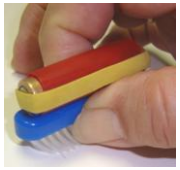
Get Ready to Rumble
Build your Racing BrushBot

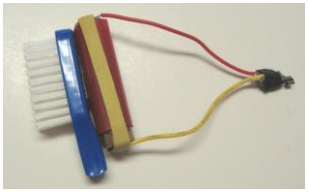
Use UGlu strip to attach straw to toothbrush: note 2 ways of attachment

Insert AAA battery into straw and wrap the rubber band around the battery



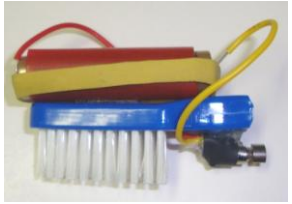
Train the bristles by bending bristles

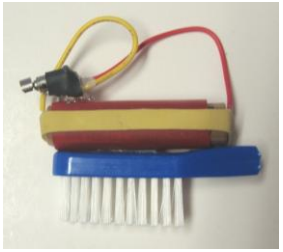
Failure is not an option.

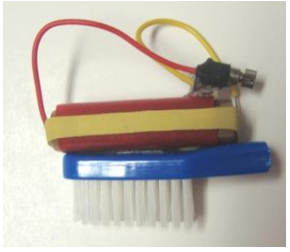


Insert motor wires between rubber band and battery (switch=close the circuit: motor should begin vibrating)

Note different locations of the motor







May the force be with you

Design/build your brushbot:

*Place toothbrush head on a table top and vibrate table by gently hitting the table top with your fist; see the natural movement of the brush. You can "train" the bristles by sliding the bristles against the table top or hand.

*Use the double stick glue (UGlu) strips to attach the straw (battery holder) to the brush head; the straw can be attached in line or perpendicular to the brush length.

*Place the AAA battery in the straw, and put the yellow rubber band around the battery.

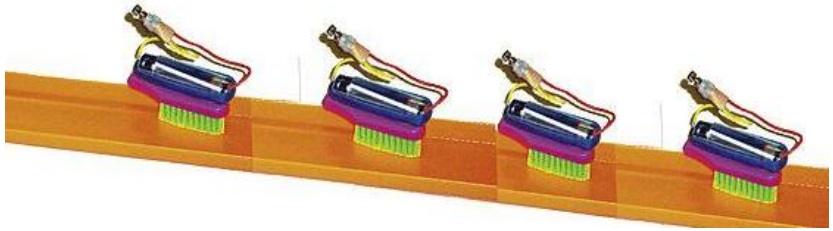
*Test the micro motor by placing the stripped ends of the wire at each end of the battery (use rubber band to hold the wire to contact the battery). The motor should vibrate.

*The motor can be attached using UGlu strips to the straw or to the brush head or left freely dangling.

*Optional: use origami or other materials to create costumes for sumo and figure skating brushbots, including plastic straws, paper clips, small photos, stickers, cardboard, etc.

*Only bristles can touch the competition surface.

BrushBot Olympics



Why BrushBots

Despite proliferation of robotics programs in schools (over 500 teams)…relatively few students and teachers have the opportunity to have a hands on experience with robots as tools for teaching and learning due to cost, other resources, lack of awareness, complexity, lack of training….most robotics programs are done after school for selected students, limiting participation….therefore, BrushBots

***Low cost ($2-$3 per robot), easy to construct, variable designs and outcomes**

***Tool to address: specific science, mathematics and career/technical education standards…and the General Learner Outcomes**

***Measurement through game challenges**

***Lead in to participation in more complex robotics opportunities (see www.robotics.hawaii.gov)**

***Engaging and they are….fun fun fun**

What's happening? ...the science behind the brushbot.....it is all about scientific inquiry and friction, center of gravity, inertia, closed and open circuits

Your brushbot should crawl erratically over any smooth, flat surface and maybe even fall over occasionally – if you're getting no movement try bending the bristles a bit or trying a different surface. To understand how it works, imagine holding a heavy bowling ball and taking a run-up as if to throw it, only to have your fingers stick in the holes at the last second. You'd probably be thrown off balance and fall flat on your face. This is called '**inertia**' (Newton's first law of motion). An object in motion will stay in motion and an object at rest will stay at rest unless acted on by an unbalanced force.

The unbalanced motor works in a similar way. Unbalanced by the weight, the motor's spinning shaft makes it vibrate rapidly, in turn making the toothbrush head shake in one direction and then back again very quickly.

Cell phone motors used to create vibration alerts in consumer electronics use this technique. As the motor shaft spins, the weight on the shaft, being off-kilter, makes the motor, and therefore the entire pager, vibrate. A tiny motor thinner than a pencil with an unbalanced weight is whizzing around each time the phone rings. This vibration is transferred to the whole phone making it all vibrate and alerting you to the call.

So why doesn't it just sit in one place and buzz? Why does it move forward? Most toothbrush bristles are angled just like the hairs on a gecko's foot, meaning they'll slide smoothly in one direction, but not so easily in any other. The brushbot is thrown forward by the swinging weight and the bristles slide along the surface a short distance. When the weight swings back again, the bristles catch and resist moving. This way the brushbot creeps along the surface using friction, pushing along with its bristly feet.

In some ways, your brushbot works a little like how a snake eats. Snakes have teeth which are angled backwards, just like the bristles on the toothbrush. Any prey they consume can move in easily.

The surface **friction** on which a brushbot moves will affect the behavior of the brushbot. Practice on the surface that the brushbot will be competing on.

Friction is actually a force that appears whenever two things rub against each other. Friction is a 'catch all' phrase for any force opposing the relative motion of objects in contact. Friction releases some of the energy. This release can be in the form of noise, vibration, and energy transfer. Friction can also transfer energy into heat energy. If you rub your hands together you will notice that the skin on your hands warms up. Some of the energy of motion in your hands is transferred to heat energy through the friction process.

Brushbots fall over easily: consider where your motor and other items added are attached in order to create a balanced system. **Center of gravity** is the exact spot on an object where there is the same amount of weight on one side of the spot as there is on the opposite side. Once you change the weight anywhere on the object, the center of gravity changes too. The ease with which an object can be balanced depends greatly on the location of its center of gravity.

Some ideas for your consideration….

*Mount the motor on the end. This will convert as much vibration as possible into axial motion.
*Mount the motor on the rear end. This tends to lift the device off the front bristles and reduce friction.
*Mount the battery on the handle end. (Similar principle as above)
*Remove the middle bristles. This eliminates friction from unneeded center bristles.
*Split the bristles. (Similar principle as above)
*Cut a slot in the plastic. The lightest, longest tends to move faster. (Notice how ships are designed)
*Cut the sides of the plastic. (Similar principle as above)
*Use a tail. This will tend to convert unwanted sidewards movement into axial motion along the track.
*Change the vibration pattern by modifying the motor shaft by an unbalanced weight which may create more vibration, and/or slow the motor.