Robots Game Plan

eCamp Flight Lab

Objective You're going to be using your circuits and burglar alarms together with a frame to build a set of real, working robots. We're going to spend most of our time learning *how* to get the electrical components to work together, and not very much time on how they individually work. For example, we're not going to talk about how a motor transforms electricity into a spinning motion, but rather how to wire up a set of motors to make a robot move forward and reverse. It's more important to learn how these elements work. (The details concerning *why* they work comes a bit later down the line.)

Robots are electro-mechanical devices, meaning that they rely on both electronics and mechanics to do their 'thing'. If a robot has sensors, it can react with its environment and have some degree of *intelligence*. When scientists design robots, they first determine what they want the robot to do. *Turn on a light? Make pancakes? Drive the car?* Once you've outlined your tasks, then the real fun begins… namely, figuring out exactly *how* to accomplish the tasks.

About the Experiments The robots in this section aren't going to look very flashy. In fact, they may all look about the same – all made of wood, metal, and wires! That's because we're focusing on the harder parts (the movement and framework), and leaving the decoration and flashy stuff to you. Once your kids wrap their heads around how to get their robot moving, ask them how they could improve it (make it less wobbly, faster, louder, brighter…etc).

In our live Science Camp Workshops during the summer, we spend an entire day just on this section. First, we have all the students make the Jigglebot (because it's the fastest to build) and then the Racecar (so they see how to do the wheel-axle assembly), and then we leave the lab open for the remainder of the time and let them have at the rest of the materials. The adults basically sit back and let the kids figure out how to build what they want, and are simply available to answer questions, find oddball parts, or drill holes when needed. It's a great open-lab environment that works well with large groups of students. (Although if you're nervous about doing this, just stick with the robots we've outlined and your kids will still have an outstanding learning experience.)

Troubleshooting Electricity experiments can be frustrating because unlike other activities, you can't tell where you're going wrong if the circuit doesn't work. Here are the things we test for when troubleshooting a circuit with the students:

1. Are the batteries in right? (Flat side goes to the spring.)
2. Is the connection between the alligator clip and the wire a metal-to-metal connection? (Often kids will clip the alligator clip onto the plastic insulation.)
3. If it's an LED that you're trying to light up, remember that those are picky about which way you hook up the plus and minus (red and black). Switch the wires if you're having trouble.

4. Change out the wires. Sometimes the wire can break inside – it can get disconnected from the alligator clip inside the plastic insulation, but you can't see it. When it doubt, swap out your wires.

The *How* and *Why* Explanation Leonardo da Vinci designed a mechanical knight back in the late 1400s. His drawing sketched out how it could sit upright and move arms, legs, and jaws. Jacques de Vaucanson, in the late 1700s, created the first life-sized mechanical automatons, including a mechanical duck that could flap its wings. It was the Japanese toy industry that really kicked off the mechanical revolution of inventions with complex mechanical inventions that could either paint pictures, fire arrows from a quiver, or serve tea. Not long after, in 1898, Nikola Tesla demonstrated the first radio-controlled torpedo. In 1948, the first electronic autonomous robots (robots that do their 'thing' automatically) were *Elmer* and *Elsie*, who could sense light, contact, and navigate through a room.

By putting together motors, switches, lights, buzzers, light detectors, tilt and motion sensors, and pressure sensors, you can develop a homemade robot worthy of the science fair's winner's circle.

In addition to interacting with their environment, robots need to be able to move somehow. Robots can move by spinning wheels, turning propellers, moving pistons, grinding gears, or by eccentric (off-center) drive.

While the instructions for the robots focus mainly on the chassis (body or frame) and locomotion (movement), you will want to add lights, buzzers, and any sensors from the *Burglar Alarms* section to make the robot your very own.

Questions to Ask When you've worked through most of the experiments ask your kids these questions and see how they do:

1. How can you add headlights (LEDs) and a horn (buzzer) to the Racecar robot?
2. Did you figure out how to make the Waterbot go both forward and reverse?
3. What makes the Jigglebot and Bristlebot move?
4. What's the difference between a SPST and DPDT switch? Which would you use when?
5. How would you improve the Cookie Snatcher Robot Arm?