Spooky Science – Hydraulic Egg Box Monsters

Oct 11, 2011 Vicki Dennison

This activity introduces kids to hydraulics by making animatronic egg-box monsters. Great all year round - brilliant for a Halloween themed Science lesson!

Science can be fun all year round, but Halloween offers a real chance to shine with some spooky science lessons! Perhaps the gore of biology, and the slime of chemistry are more obvious topics, but there is no reason why students can't take a creative look at physics as well.

Introducing Hydraulics

Hydraulics are often used in car brakes, and this is a concept which the majority of students will be aware of, but there are many other, more interesting ways in which the same principals can be applied, one of the coolest being animatronics.

Within a hydraulic system there are two pistons (or cylinders), the slave piston, and the master piston. An input of pressure to the master piston causes that pressure to be transferred through the system, so that a resultant movement is seen within the slave piston, which is usually some distance away from the controller and the master piston.

The pressure within a hydraulic system remains constant because the system is filled with hydraulic fluid, which does not contract when compressed.

Hydraulic systems also have the advantage that by altering the relative bores, or circumferences, of the two pistons, a small movement of the master piston can produce a large movement in the slave piston, or vice versa. This makes them ideal for using small movements to control enormous cranes and industrial machinery, and also means that the relatively clumsy movements of a human operator can be translated into the fine movements of the facial expressions of detailed small scale animatronics figures.

Hydraulics and Animatronics

Hydraulics are used in animatronics, allowing operators to remotely control the movements of their animated figures. Depending on the size of the character and the type of movement required, different systems are employed by the builders and operators of animatronics. The systems may be hydraulic (using fluid to maintain a constant pressure) or pneumatic (using pressurised air or gas in the system).

The pistons or cylinders used in animatronics are referred to as actuators, but the principles are exactly the same, allowing an applied force to be transferred within the system to remotely control the movements of an animated figure. Actuators can vary in size from several feet long, for example to control a large dragon or dinosaur, to a few millimetres long, for example to control the blinking of an eye of a small figure.

A simple example of an animatronics system is the opening and closing of an animated figure's mouth. The instructions below will enable students to replicate this by making, and controlling the movements of, an egg-box monster.

Making Egg-Box Monsters

To make egg-box monsters you will need (per group / student):

- An egg-box;
- 2 plastic syringes;

- A length of rubber (or silicone) tubing;
- Water with a few drops of food colouring (optional); and
- Assorted ‘scary’ craft materials.

Students construct a ‘hydraulic’ system using two syringes connected via a rubber tube. Filling these with water is possible, but potentially messy. Using air in the system still provides a good demonstration of the transfer of force and movement, although there will be a slight delay in response as the air within the system will contract. Using air in the system, rather than water provides a great starting point for discussions about the properties of matter, and why hydraulic fluid is used instead of a gas.

Students decorate their egg box, with the front of the box forming a mouth. This is where students can let their creativity flow! The egg boxes can be decorated with big scary eyes, sharp pointy fangs or teeth, fur fabric, paint, glitter or anything else which happens to be at hand. It is good to remove the inside flap from the box so that it doesn’t ‘lock’ shut.

By making a hole in the bottom of the box near the opening at the front, the rubber tube can be fed through, and the slave piston (syringe) secured inside using blu-tack or modelling clay. It is important that the syringe is secured to both the top and bottom sections of the egg box, so that the monster’s mouth can be closed as well as opened. Students can then connect the master piston (syringe) to the other end of the tube in order to control their monster’s mouth.

Having a range of different volume syringes available affords students the opportunity to switch master pistons, testing different sizes, and observe the effect of these changes on the movement of their monster. This can also provide a valuable reference point for introducing the mathematical concepts associated with transfer of pressure within hydraulic systems.

Sources

- Animatronics.org, "Behind the scenes." Accessed October 2011.