SISP ROBOTIC ARM CHALLENGE

Introduction/Motivation

Have you ever seen a car lifted into the air at an auto repair place? Have you ever wondered how an elevator can lift a load of people up into the air? Well, after this challenge, you'll have a better understanding of how these work, because we're going to look at hydraulic systems.

Hydraulic systems use a liquid, usually oil, to transmit force. This system works on the same principles as other mechanical systems and trades force for distance. Hydraulic systems are used on construction sites and in elevators. They help users perform tasks that they would not have the strength to do without the help of hydraulic machinery. They are able to perform tasks that involve large amounts of weight with seemingly little effort.

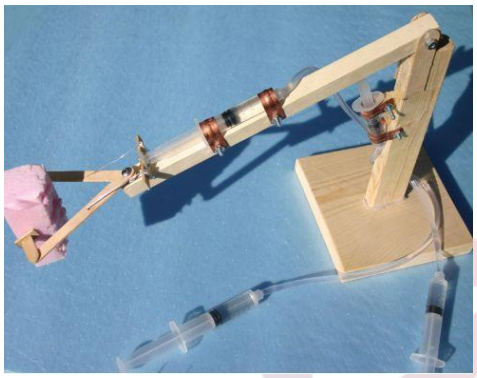
Background

Hydraulic systems are used in many different types of machines: control surfaces on airplanes, elevators, automobile lifts, and backhoes. The idea behind a hydraulic system is that force is applied to one point and is transmitted to a second point using an incompressible fluid. You can find detailed background information on how hydraulic machines work at: http://science.howstuffworks.com/transport/engines-equipment/hydraulic1.htm.

The Challenge

In this challenge students design and build a mechanical arm that lifts and moves an empty water bottle using hydraulics for power. Small design teams (3-4 students each) investigate, plan, design, build and test a model hydraulic robotic arm. The groups must work to communicate effectively through written and verbal communication and sketches.

Materials List



Each group needs:

- plastic syringes
- plastic tubing
- paddle pop sticks
- bolts, screws, nuts, washers
- foam tray

To share with the entire class:

- masking tape
- drill (for teacher use or with appropriate supervision)
- empty water bottle

Procedure

This activity is comprised of two parts:

- Part 1 – Investigate, plan, design a model hydraulic robotic arm (1 X 60 minute lesson)

- Part 2 – Create and test the hydraulic arm. (Three 60-minute lessons) Students will use the first period 1 to complete Part 1 and 3 periods to complete construction in Part 2.

Quality Rubric

	Excellent	Good	Sound	Poor
Define, Identify, Iterate	Students had a detailed design plan that included at least one drawing with labelled parts. Students performed at least two sets of tests and altered their design based on the tests.	Students had a design plan that included at least one drawing and a written description. Students tested the design solution and altered their design based on the tests.	Students had a rough design plan. Students tested but did not make changes based on the tests.	Students did not have a design plan. Students did not test.
Prototype	Great care taken in construction process so that the structure follows plans accurately.	Construction was careful and accurately followed the plans.	Construction was careful and somewhat followed the plans.	Construction appears careless or haphazard. Many details need refinement for a strong product.
Evaluate	The hydraulic arm lifts the bottle and is able to place it somewhere else.	The hydraulic arm can grab the bottle and lift it of the ground.	The hydraulic arm can grab the bottle.	The hydraulic arm cannot grab the bottle.

Vocabulary/Definitions

hydraulics: Involving or moved by fluid under pressure.
prototype: A working model of a new product or new version of a product.
pneumatics: Involving the mechanical properties of air and other gases. Safety Factor(N): A number used to describe how much more force your device should withstand past the max expected force based on a number of parameters such as material and dimensions (N=1 means only can withstand 100% of expected force, so it will fail at 101% of expected load)..