## Easy Hydraulic Machines

**by** [WYE_Lance](http://www.instructables.com/id/Easy-Hydraulic-Machines/) on March 28, 2012

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**Intro: Easy Hydraulic Machines**
After the success of the JudoBots, I decided to explore more projects that use simple hydraulic systems. Hydraulics made from plastic syringes and vinyl tubing are so easy to make and add an element of sophisticated movement to otherwise rather hum-drum projects, and yet it's only utilized in robotic arm contests for high school students.

In this Instructable, I'll to show you how to build many projects that use a simple hydraulic system that kids in elementary school can build. It's like four Instructables combined into one!

**Learning Objective**
By creating a simple hydraulic system, students will comprehend the basic mechanics behind hydraulics (transferring kinetic energy from one piston to another by pushing water through the tubing). Applying these hydraulic systems to simple machines will allow students to experientially understand how hydraulics can be used to power machinery. Building the simple machines will give students an understanding of how hinges and levers work. Finally, students will refine their critical thinking and motor skills as they build, test, and redesign their easy hydraulic machines.

**Materials**
These are the essential materials, but you could of course add to this list. 
Craft sticks, craft cubes, cubes with holes, skewers (less than 1/8" diameter), 10ml plastic syringes (bulk), vinyl tubing, cable ties, tape, and hot glue.

First thing's first: How to make a hydraulic system

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**Step 1: Simplest machine**
The video gives you an overview of the simplest hydraulic machine - the photos tell you how to build it! I've had kids as young as 1st grade build this project.
Image Notes
1. Just a square of craft sticks with a cube glued in the middle on one side.

Image Notes
1. Glue craft sticks to the front and back of the blue cube with an additional cube with holes at the top. The holes should be exposed just like the picture.

Image Notes
1. The lever can be this simple, but can also be much longer/stronger/more interesting.
1. Use a 4” cable tie to bind the cubes with holes together - this creates the fulcrum.

1. Tie the piston to the lever. With the piston completely empty, pull the lever to its most downward position. Tape the piston in place as it's shown in the very first picture.

1. Get creative!
Step 2: Hydraulic box
This time all you need is the vid!

Step 3: Hydraulic drawbridge
The hydraulic bridge project was originally conceived by a student named Daniel H.D. Thanks Daniel!

Like before, the video gives you the project overview and the photos show you how to build it.
Image Notes
1. Thread 4 cubes with holes on a skewer that's as long as a craft stick.

Image Notes
1. The two innermost cubes are the moving part of the hinge
Image Notes
1. Cube with a hole will be used to secure the hydraulic piston to the base
2. Craft stick glued to the underside of the bridge will be used to attach the hydraulics to the bridge platform

Image Notes
1. Cable tie the nozzle of the piston to the cube - make sure it's tied to the nozzle, not the tubing.

Image Notes
1. One more cable tie secures the piston to the bridge platform

Image Notes
1. Try it out!
Step 4: Hydraulic fortune teller

The hydraulic fortune teller uses the same mechanics as the Judobot to achieve 3-dimensional movement, however this project is easier to build because it doesn't need to be thoroughly designed to battle. I like the idea of a fortune teller, but the face can be replaced with other things to create a variety of projects: a catapult arm, a serving basket, cannon.... be creative!
Image Notes
1. When building the pivot column, insert a skewer into these two cubes to ensure the holes will be aligned.
2. Insert a skewer into these two cubes before gluing them on - this ensures that the hole will be aligned.
3. This cube with hole will attach to the end of the piston which actuates the pivot.

Image Notes
1. This cube will attach to the top of the pivot column.
2. These sticks will be taped to the face of the fortune teller.

Image Notes
1. The pivot column should slide onto the base pretty easily.

Image Notes
1. Insert a small piece of skewer through the cubes to create a hinge.
1. In this picture, all three cubes are connected with a piece of skewer.

2. To calibrate: Set the piston to 5ml (halfway). Face the fortune teller forward. Align the cube on the end of the piston directly under the pivot column cube, and tape the piston in place. Now the fortune teller should be able to move left and right with equal range.

1. A small piece of skewer with a bit of hot glue on one end attach the piston cube and the pivot column cube together, creating a hinge.

2. To calibrate: Set the piston to 5ml (halfway). Move the fortune teller’s ‘head’ in a level position and place the piston underneath. The ‘head’ should rest on top of the piston’s cube. Tape it in place. Now the fortune teller should move up and down with equal range.

2. Use a cable tie to secure the piston to the fortune teller’s ‘head’.

Step 5: Lesson plan for teachers

The way I teach these projects is pretty straightforward. Hydraulics are most easily understood by the students if I allow them to play with a few pre-made systems before class. In my experience, children in grades 1-3 have a hard time conceptualizing what it means to transfer energy by pushing water from one piston to another.

I begin the lecture by showing a project that has been stripped to its bare components, which removes visual clutter. Next I break down each part of the project into manageable pieces. For example, the simplest machine has two parts: the base + stand, and the lever; the fortune teller has the base, the pivot column, and the face (lever). As I explain each component, I point out the project’s key features such as hinges, levers, and where the hydraulics attach.

After outlining the project, I demonstrating how to make a hydraulic system, at least three times, since the process isn’t very intuitive and young kids have difficulty following the steps. The key is to remove all of the air - air can become compressed, which means that instead of moving energy from one piston to another, the air will simply absorb that energy by getting squished! Sometimes I prepare the hydraulic systems before class if my class time is limited or if I’m working with a young population. After I get the sense that the students are feeling confident and ready to begin, I allow them to gather their materials from pre-sorted bins and start building!

Thanks for reading through this Instructable! If you make any hydraulic machines, please post some photos for us :) If you like what I’ve done, consider voting for my projects in the education contest. Thanks!

Related Instructables

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Teach Engineering: Slingshot Rockets (video) by WYE_Lance
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