Fluid Power Laboratory
Module 2

Deadweight tester and fluid power relationships (Pressure, force, area)

Report: Answer the green bolded questions for report submission. Turn in one report per group and upload a video of your working system, and make sure to write your names (first and last name), lab topic, and section day and time.

Lab objectives

1. Design and build a working model of the deadweight tester using the provided materials
2. Create a procedure for estimating the maximum amount of weight the deadweight tester can safely raise up using the design created

Background

Hydraulics can be defined as "as a technology and applied science using engineering, chemistry, and other sciences involving the mechanical properties and use of liquids" (Webster's online dictionary, 2018). Pneumatics is defined "as a branch of engineering that makes use of gas or pressurized air" (Webster's online dictionary, 2018). Both have different properties and are used for different tasks in industry. Pneumatics are used because they are safe, economic, and flexible. Examples are rock drills, paint sprayers, blast cleaners and more. Hydraulics are used in items we use every day like car brakes, gasoline pumps, elevators and more.

Discussion

Students can work in **groups of 3 or 4** to **design** and **build** a **deadweight tester** using the materials provided to (safely) raise up as much weight as possible.
A deadweight tester is a calibration standard that uses Pascal's principle to build a pressure balance to calibrate pressure measuring instruments (*Figures 1-2*).

Figure 1. Deadweight tester model

Figure 2. Example deadweight tester built by students

The components presented in *Table 1* will be provided for building the deadweight tester.

Table 1. Utilized material for building the deadweight tester

No.	Material Name	Quantity	Characteristics	Image
1	**Square Wooden Sticks/Dowels**	5 & ½	of about 60 x 0.635 cm (1/4 x 24 in) length.	
2	**Square Wooden Slats**	2	of about 10 x 10 x 0.25 cm (4x4x0.1 in)	
3	**Circular Wooden Slab/disc** ***should be 3D printed**	1	of about, 5.5 x 0.5 cm (2 x 0.2 in) *This must have a 2.2cm (0.86 in) diameter hole in the center.	
4	**Hot Glue Gun**	1	with about 4 to 5 glue Sticks	
5	**Syringes**	2	20cc (20ml)	
6	**Hoses**	3	(1/8 diameter or syringe fitting)	
7	**Dovetail Razor Saw**	1	18 TPI, 020-Inch Kerf	

Getting started

Answer the following questions prior to getting started with the project.

a. What design principles will you need to use to create a deadweight tester with the kit provided?
b. What calculations/physical principles of Force will your group use to determine the amount of weight that the deadweight tester can raise up?

Procedure

1. Using the Dovetail Razor Saw, take the wood sticks and cut (as shown in *Figure 3*):

   a. 8 pieces of **12 cm** (4.72 in)
   b. 8 pieces of **20 cm** (7.87 in)
   c. 2 pieces of **30cm** (11.811 in)
   d. 2 pieces of **8cm** (3.14 in)

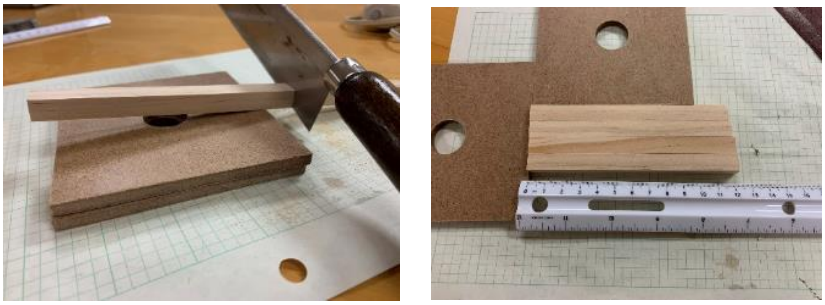

Figure 3. Wood sticks cutting

First, the syringe component will be built, see Figure 4 below.

2. Put the syringe inside the circular disc and glue the inside part of the finger flange at the end of the barrel.

3. Glue together two pairs of 12 cm pieces and place them on the sides of one syringe and stick one of their ends to the disc.

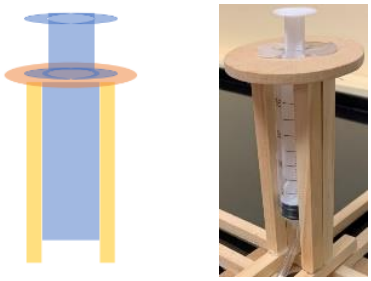

Figure 4. Syringe component

Now, a Cross Base shape must be built, see Figure 5 below.

4. Put one wooden slat on a flat surface and lay the 2 wood pieces of 30 cm on top of it. These must be centered evenly, and parallel to the slat, and you must leave a space of about ½ inch between them, so two other sticks can fit in between them.

5. Lay 2 wood pieces of 12 cm on top of the slat and align them parallel to the previous 2 wood pieces of 30 cm, as shown in Figure 5.

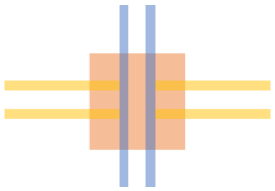

Figure 5. Cross base

6. Next, lay the 2 pieces of 8 cm aligned and over the 12 cm pieces, centered with respect to the wooden slat, and parallel to the 30 cm pieces.

7. Finally stick the first built Syringe Component from steps 2 and 3 to the top and middle section of the 8 cm pieces as shown in *Figures 6-7*.

Figure 6. Cross base and syringe component built up

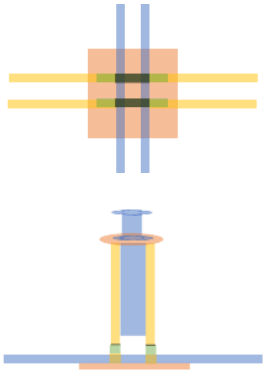

Figure 7. Cross base and syringe component diagram

Now, the inclined Stick Pairs that will give support to the structure must be adjusted from the ends as shown below in Figure 9.

8. Take every 20 cm piece, and from one end, cut them making a single 45° angle cut, so you leave the pointy end continuous to the surface of the stick (see Right End of stick diagrams, *Figure 8*), and the other side, making two 45° angle cuts, leaving the pointy end by the middle of the stick (see Left End of stick diagrams, *Figure 8*).

9. Couple all the cut sticks aligned and stick them together. You should end up with 4 Stick Pairs, like so:

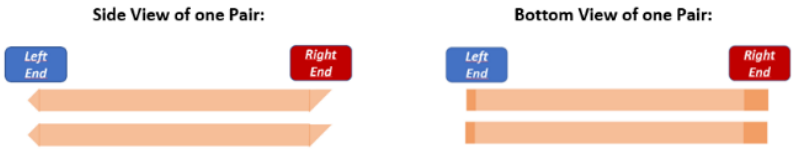

Figure 8. Stick pairs diagram

10. Finally, stand the Stick Pairs in between the spaces of the Cross Base´s ends, with the Right Ends of stick diagrams to the floor, and the other Left End to the circular wooden slab bottom side. See *Figure 9*.

11. Center the square wooden slat on top of the plunger end, and glue it generously. (This example was done with a hole on the wood slat, but it can be done without it).

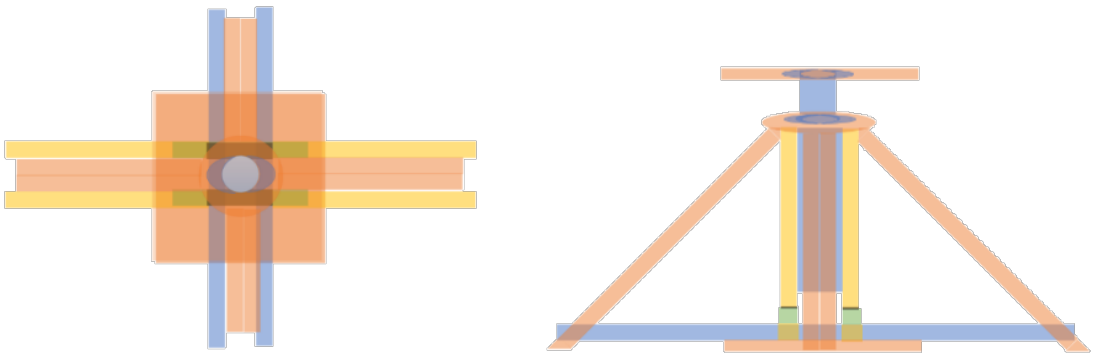

Figure 9. Deadweight tester diagram

12. Connect a second syringe to the deadweight tester using the hose provided.

Testing and observations

1. **Provide a photo of your deadweight tester**.
2. Test the amount of weight the deadweight tester can raise up.
3. **Which fluid works best for this experiment (air or water)? Why?**
4. Increase the amount of weight raised by adding or changing syringe sizes. **What do you notice?**
5. **How important can it be in building your machine to understand the differences between pneumatics and hydraulics?**

6. **What are some uses of hydraulics and pneumatics you see daily?**
7. **How do you see using either in industry or in your future career?**
8. **Where did you observe that energy was lost when you were moving the weight?**

Report

Please, answer green bolded questions. Turn in one report per group and attach the required pictures. Make sure to write your names (first and last name), lab topic, and section date and time.

Thank you