**Title:** Design a Derrick
**Essential Question:** Can you and your teammates engineer the derrick that will support the most weight?
**Grade:** 4-12
**Time:** 40min-1hr

**Overview:** The tall part of the drilling rig is called the "derrick." It is the part of the hoisting system that is designed to lift and hold the heavy pipe needed to drill. Engineers design these structures, which must be strong enough to handle this heavy job. Can you build a derrick to hold some heavy equipment?

**Assessment:** Derricks must be greater than 8in tall and have a flat surface at the top on which a paper plate can be rested in order to hold multiple poker chips for testing. Once constructed begin by placing a plate on the top of the derrick and slowly adding poker chips counting how many are being placed on the plate. Once the derrick fails either count poker chips or record the current number.

**Vocabulary:** Derrick, engineering, force, load, bending, compression, shear, tension, torsion

**Teacher Information and Procedure**

**Prior Knowledge for students:** n/a

**Source:**

**Materials needed:**
- Approximately 15 pieces of spaghetti per group
- Approximately 5 marshmallows per group
- 1 Paper plate to build the derrick on per group
- 1 strong paper plate to use for testing (needs to be able to hold some weight)
- Poker chips or other small individual weights to be used for testing. (a really good Derrick can hold up to 600)

**What to do in advance:**
- Read the background information and all the directions for the activity
- Make copies of profit analysis sheet
- Based on material bought by students give out said material.
- Bag of poker chips to place as weight (any small, scalable weights can work.)

**Teaching the Lesson:**
Gear-up
Begin by discussing oil and gas exploration. Seismic data is collected and analyzed to decipher where in the earth the oil is located. Then core sampling is done in order to decide the validity of the seismic data. Drilling can then begin; the derrick supports the large sections of pipe used to bring the oil to the surface.

**Explore**:

- Have the students begin by looking at the “Design-A-Derrick” profit analysis sheet. Explain that the pieces of spaghetti are the steel beams used to construct an oil derrick and the marshmallows are the nuts and bolts that will hold everything together. Have students then sketch their designs on the back of the profit analysis sheet, once they have finished, they should then be able to make an educated guess as to the amount of materials they will need. Feel free to put a limit on it based on the amount of materials you have.

- Once students have materials, they can begin construction on their paper plates. Remind them that structures must be at least 8in tall and have a flat surface at the top to place the testing plate.

- Once students are ready to begin testing give them the testing plate or any other light flat surface that can hold some weight. Give them whatever you will be using for weights, we use cheap plastic poker chips. If their design looks like it will hold some weight encourage them to place 5-10 poker chips/weights at a time, while keeping track of the number of chips in total. Generally, we provide the testing materials as the groups are ready, but some teachers may prefer to wait until everyone is done and all test together.

**Generalize:**
Discuss the engineering project: What shapes/features made up the strongest structures?

Cost vs. strength, is there a balance of cost of materials and strength of structure? Overspending but strong structure? Underspending but weaker structure?

**Assess:**
Have students explain the design and implementation of their structure. How did their design differ from their finished structure if at all? What worked well and what didn’t? How could they have changed their design after seeing others?

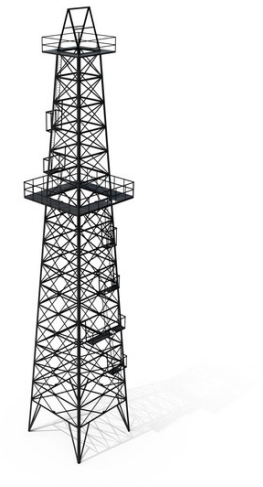
**Extensions, adaptations, and more resources:**
For younger students simply provide them with all the same amount of materials. Teachers can also provide them with a design and see who can execute it the best. Also, for younger students you can omit some of the harder math that corresponds with the lesson.

We’ve found that the process game (Great Alaska Oil Race) or the viscosity lab goes well in conjunction with this lesson.

# Design a Derrick

**Company Name:** _____

The tall part of the drilling rig is called the 'derrick.' It is part of the hoisting system that is designed to lift and hold the heavy pipe needed to drill. Engineers design these structures, which must be strong enough to handle this heavy job. Can you build a Derrick of Distinction to hold some heavy equipment?



Procedure:

- Design (plan) your derrick.
    - Structure must be > 8in tall.
    - Must have flat top in order to hold plate for testing.
- Buy necessary material to construct your derrick.
- Build your derrick.
- Test your derrick.

## Design:

Use the back of this sheet to draw out your design for your very own derrick.

## Purchase your materials:

Now its time empty those pockets, remember finding and retrieving oil isn't cheap!

**Nuts and bolts** (Marshmallows) - $2000/piece

**Steel beams** (Pasta) - $6000/piece

## Building your derrick:

Remember structures must be taller than 8 inches high and have a flat top for testing. You will rest a paper plate on top of your derrick for testing purposes.

## Testing your derrick:

Rest a paper plate on top of your derrick. Begin to add poker chips one or a few at a time. Remember to even out your load so that the plate doesn't tip over. Continue adding chips until your derrick begins to buckle and break. Once your derrick has failed count up the number of chips it took to take your derrick down!

# OILBOOM

| Costs | Price | Your Cost |
|---|---|---|
| Nuts and Bolts (Marshmallows) | x$2,000 each | $ |
| Steel Beams (Pasta) | x$6,000 each | $ |

= **Total Costs:** _____


| Profit Analysis | |
|---|---|
| # of Chips | |
| Each chip represents 50 barrels of oil<br># Chips X 50 | |
| Current price of oil per barrel | |
| Price X Total Barrels | |

Gross Income = _____

Total Costs = _____

= **Your Gross Income:** _____

Net Income (Profit) = _____