Build a Pipeline

Introduce a Girl to Engineering Day 2021

November 13, 2021

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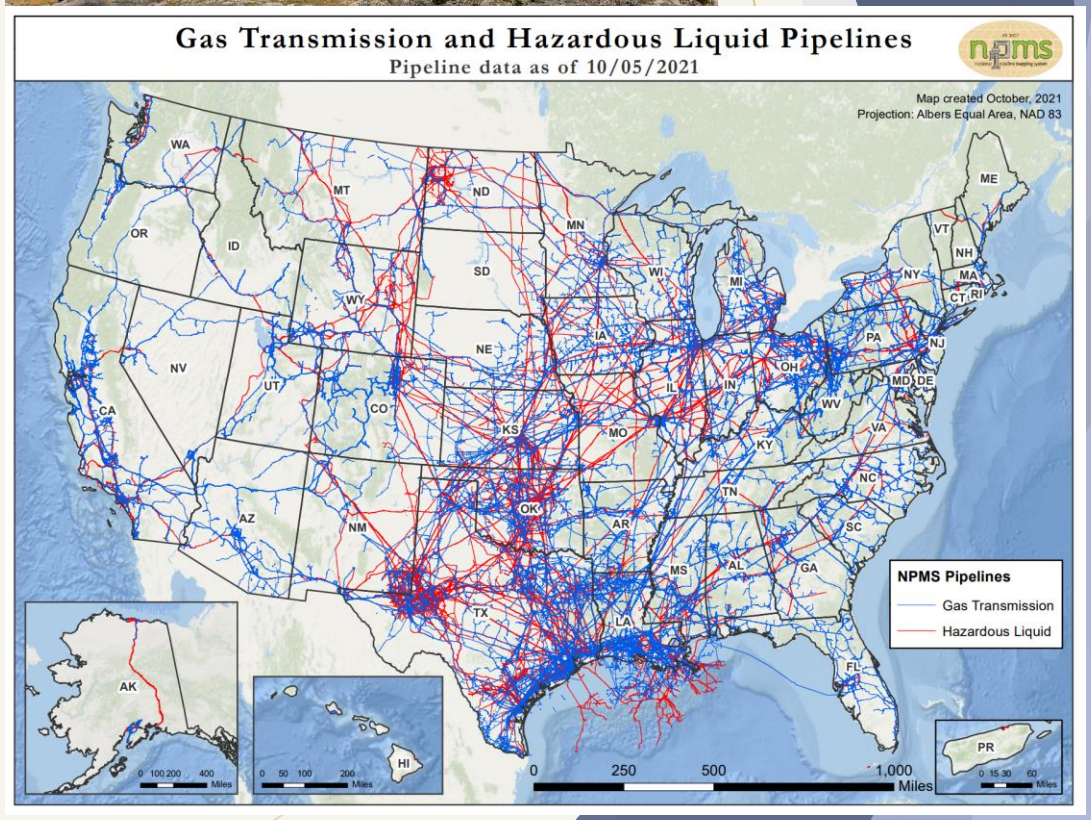
History of Pipelines

Then

- Rome used aqueducts to bring water sources from higher grounds to the city of Rome.

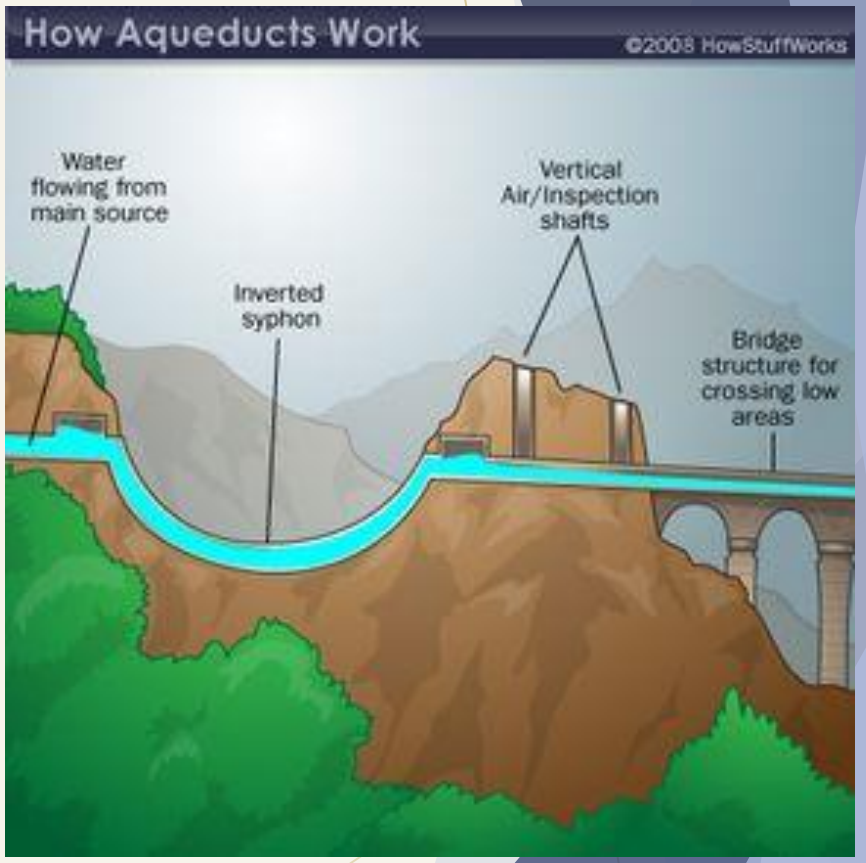
Now

- The United States has 229,523 miles of oil and 319,374 miles of gas transmission pipelines to move energy fuels from production areas to end-users.



Aqueducts

- A channel built to move water to the city
  - **Gravity flow** from a higher elevation flowing downhill to a lower elevation was used in the design.
  - Water was carried through underground channels, concrete **pipes**, or lead pipes where the city governments funded the projects.
  - When there were dips in elevation, a **siphon** was created to generate enough **momentum** of the water to continue the flow further downhill.



Ancient Aqueducts | HowStuffWorks

Women Working on Pipelines

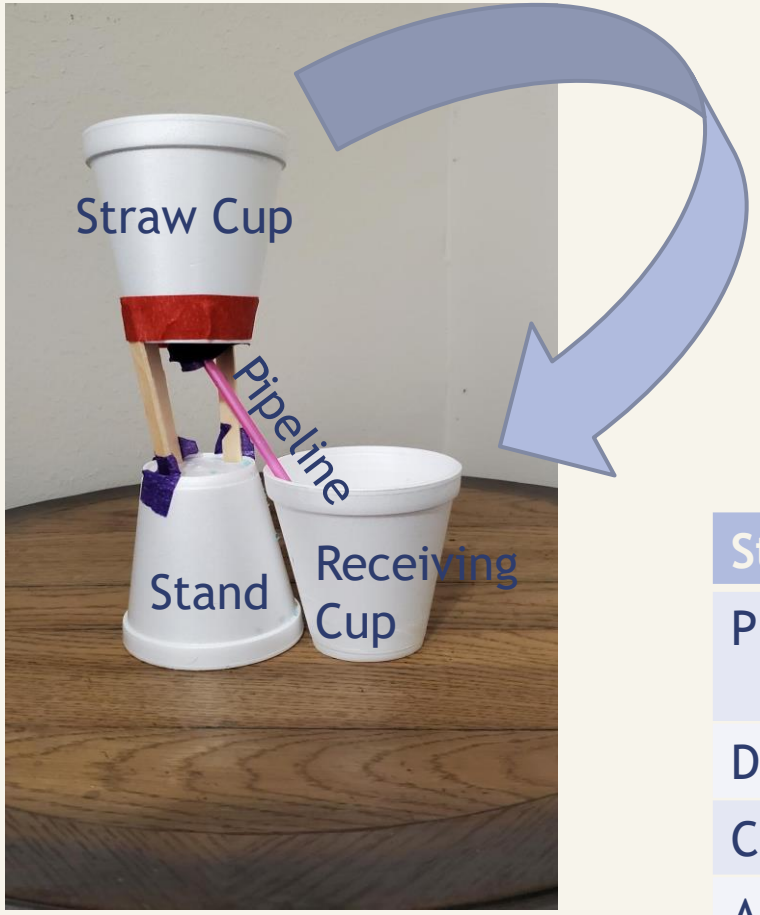
- Women comprised as much as 10% of the 28,000 employees on the Trans-Alaska Pipeline Project between 1974 – 1977
- Diane Schenker, a welder for the Trans-Alaska Pipeline, is pictured on the right in the photo.

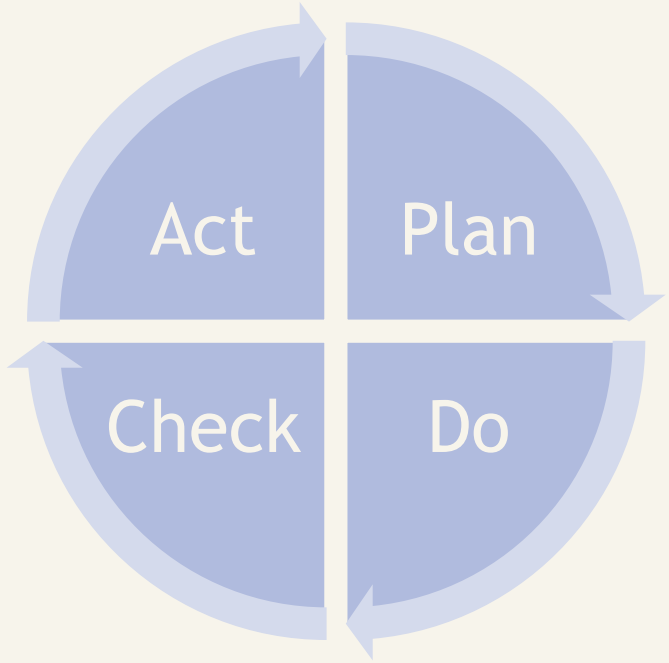
Library.Alaska.Gov

AlaskaPublic.org

Build a Pipeline Activity Objective

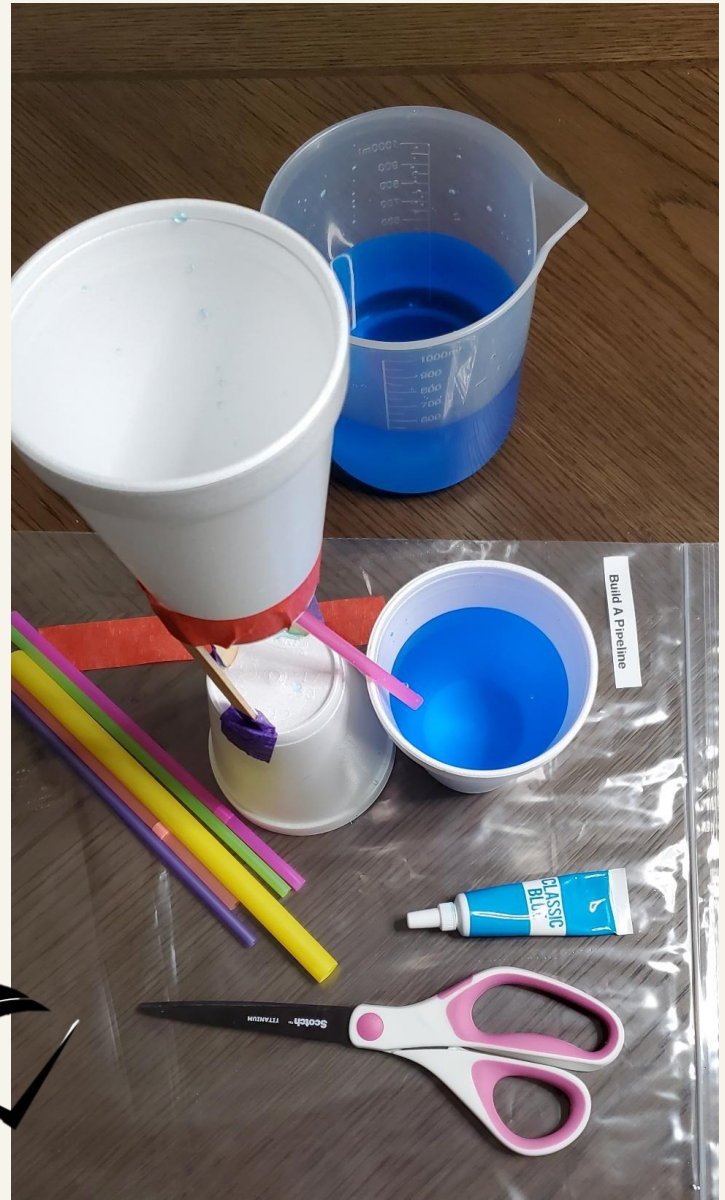
- Move water from one cup to another.





Steps	Actions
Plan	Consider how to move water from one cup to another using the provided materials.
Do	Assemble the pipeline system.
Check	Troubleshoot if needed.
Act	Make repairs, redesign, or optimize.

Materials



- Three (3) foam cups
- Straws (non-bending, bending straws, various diameters)
- Craft sticks
- Masking tape
  - Not included:
    - Scissors
    - Water
    - Paper towels
  - Optional:
    - Food coloring
    - Honey, vegetable oil, other viscous liquids
    - Timer
    - Measuring cup

Do: Steps

1. Use the scissors to carefully poke a small hole in the bottom of one Styrofoam cup.
2. Insert a small diameter straw in the hole of the first cup (“straw cup”).
3. Consider, design, and build a stand for the “straw cup” so the “straw cup” is a higher elevation than the “receiving cup” using the provided cups, straws, wooden craft sticks, and tape.
4. Configure the “straw cup” and stand to empty through the straw pipeline into the “receiving cup.”
5. Pour water into the taller cup.

Instruction Video

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Check: Make Observations

Troubleshoot as needed:

a. If there are leaks, use tape to repair them.
b. If the structure elevating the first cup is not structurally sound, reinforce it.
c. If the water does not flow into the second cup, re-design the pipeline system.

What happened?	
Observations:	
Research:	
Hypothesis:	
Testing:	
Analyze Data:	
Conclusions:	

Act: Data Gathering

a. Consider optimization of flow using larger diameter straw.
b. Consider design changes to accommodate different fluids (honey, vegetable oil, etc.)

- Constants: Use 50 mL or ¼ cup of fluid
- Variables:
  - Use two fluids with different viscosities such as water and honey or water and oil.
  - Change the narrow diameter straw out with the thicker diameter smoothie straw and see how the average time to move the water changes.
- Using a timer, record three-time trials for each fluid type and straw diameter. After recording the times, take the average of each test and compare the results to the hypothesis.

Act: Data Gathering

	Thin Straw	Thick Straw
Fluid 1: Water		
Time 1		
Time 2		
Time 3		
Average		
Fluid 2: _____		
Time 1		
Time 2		
Time 3		
Average		

$$\text{Average} = \frac{(\text{Time 1} + \text{Time 2} + \text{Time 3})}{3}$$

Additional Resources

- Pipelines
- Fluid Viscosity
- Bernoulli Principle
- PHMSA Website
- Pipeline construction
- Deming Plan Do Check Act (PDCA) Cycle