Day 1

Dams:

Controlling and Capturing the Power of Water

Made by: Julia Kendall and Mary Ashley Hand

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01

What is a dam and how do they help people?

What is a dam?

A **dam** is a structure built across a stream or river to hold water back. Dams can be used to store water, control flooding, and generate electricity.

What are some famous dams?

Hoover Dam

Dam located on the border of AZ and NV, 726 feet tall, and generates enough power for 1.3 million people each year.

Three Gorges Dam

A hydroelectric gravity dam in Central China used to control dangerous floodwaters.

Aswan Dam

One of the world's largest hydroelectric embankment dams located in Egypt.

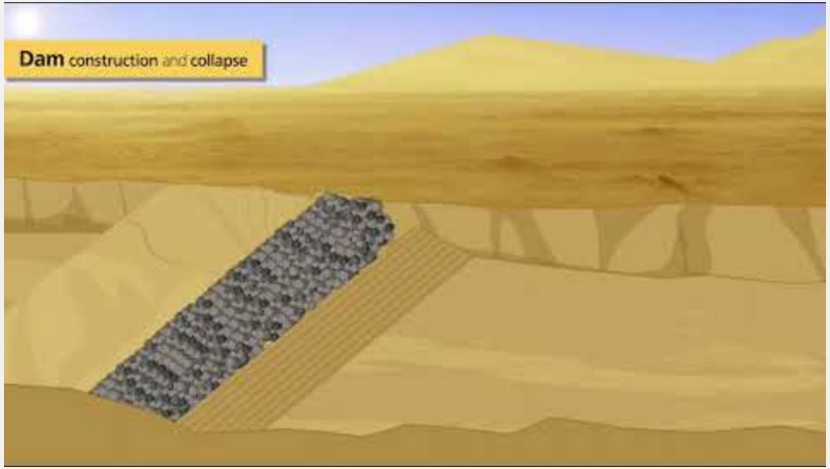
02

What is t he history of dams?

The oldeset dam in the world

Sadd el-Kafara

- Built in Cairo, Egypt around 2700 BC.
- Built from simple materials to protect Egyptians from floods but was unfortunately destroyed before construction was complete.
- Shows that more struture is needed to have a successful dam.



Modern Dam Construction

The Hoover Dam

03

Why are dams important?

Why are dams important?

They…

- Control floods
- Store water for agriculture and drinking water
- Provide recreations spaces (lakes and reservoirs)
- Create electricity
- Impact the environment
  - What are some positives?
  - What are some negatives?

04

Your Engineering Design Challenge

Engineering a Dam!

You are part of a team of engineers working together to design and build a system to dam up **6 cups of water** in an aluminum pan. The system must **completely hold back the water**, and it must have a way of executing a **controlled release** (releasing a little, stopping it, and releasing again).

Materials Available

Required for Build – per team

- 9” x 13” Aluminum pan
- Gravel or sand (for "river" base)
- Water

Optional for Build (limited amounts)

- Cardboard
- PVC pipes
- Tape
- Foil
- Plastic wrap
- Cups
- Straws
- Paper
- Binder Clips
- Wooden dowels
- Cotton balls
- Plastic sheets
- Clothespins
- Wire
- String
- Springs

What are some elements we should consider when planning our designs?

Sketch an initial design.

Day 2

What do you remember about dams from yesterday?

What are dams and why are they important?

A **dam** is a structure built across a stream or river to hold water back.

They…

- Control floods
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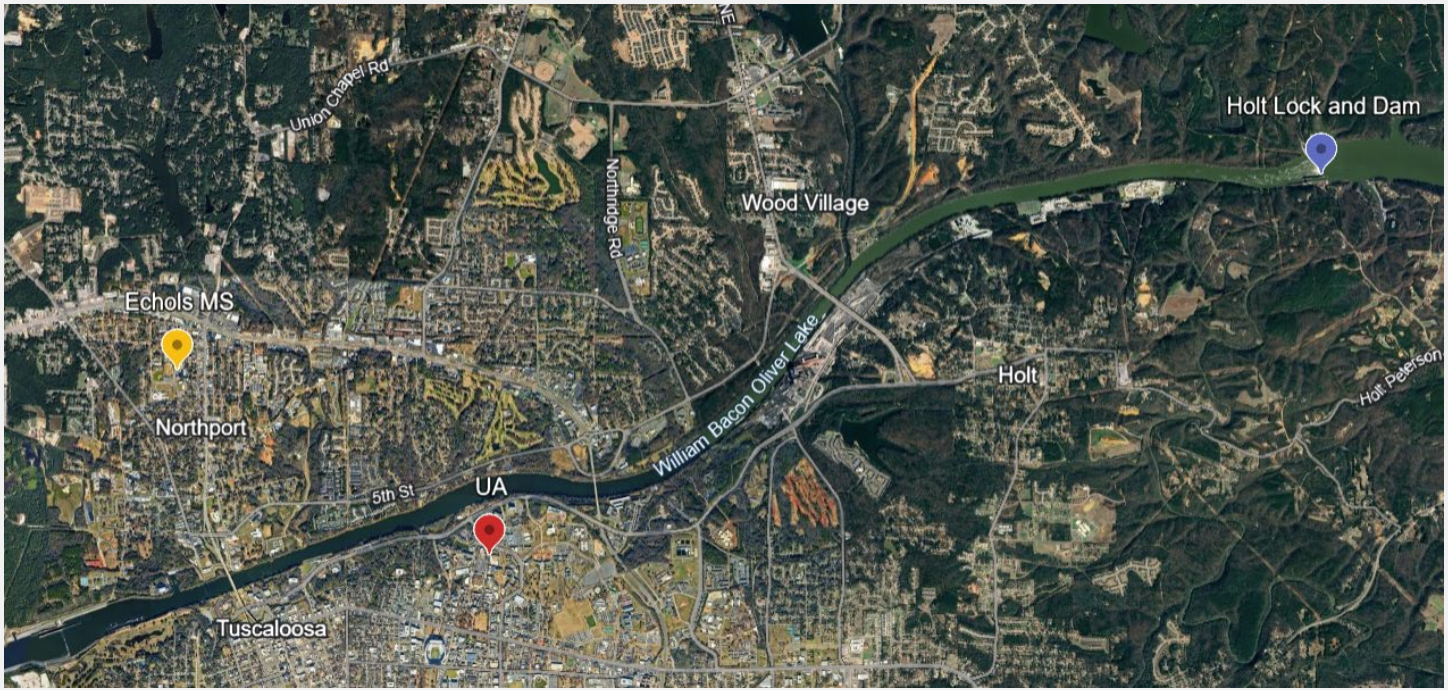
Where are dams near you?



Dams in the Southeast U.S.

Holt Lock and Dam

- Located in Tuscloosa County, AL
- Forms the 19 mile long Holt Lake
- Built by the U.S. Army Corps of Engineers in 1969
- Contains 14 indivial gates to release water and hydroelectric turbines for energy generation

Types of Dams

Arch Dam

A concrete dam which is curved upstream to distribute the pressure of the water to the ends of the structure that connect to the natural rock faces. Best for narrow, rocky locations.

Embankment Dam

Rely on materials of earth and rock to hold back water with their weight alone.

Gravity Dam

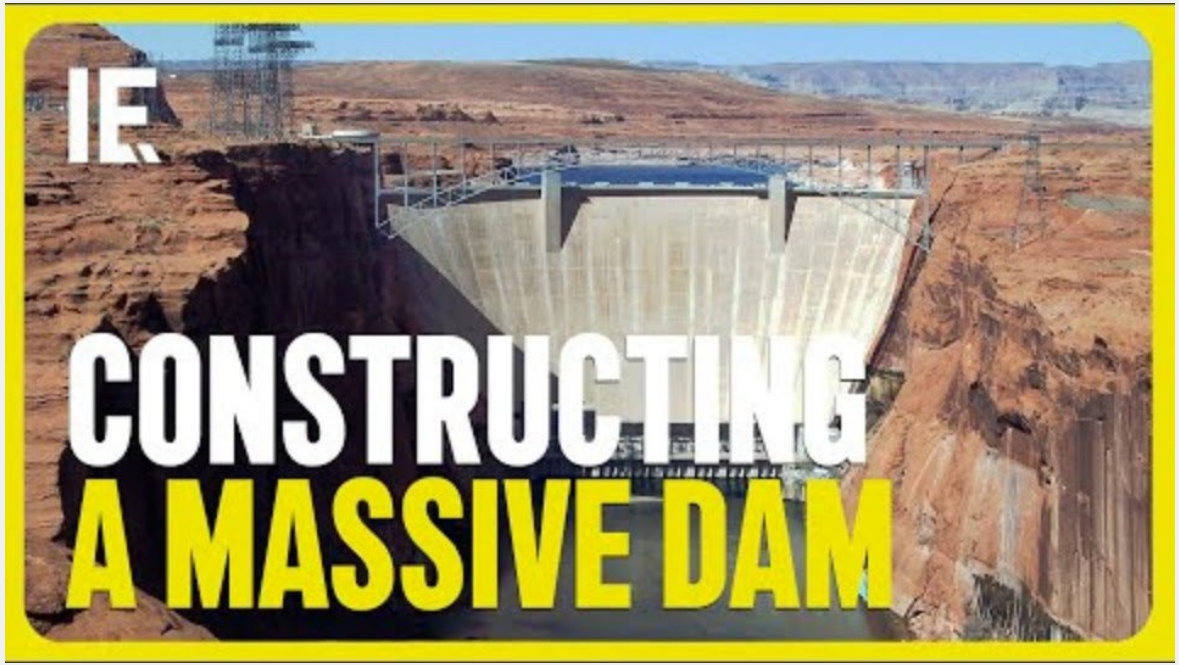
A concrete dam with straight walls that hold back water with their weight.

Buttress Dam

A dam with a series of supports, or buttresses, that brace the dam from the downstream side.

Construction of Dams

How are these huge dams constructed and with what materials?



The Engineering Design Process

Iterative Design = Productive Failure

- **The engineering design process involves productive failure:** test, fail, redesign. Iterate again and again until you have the best possible solution.
- It is important to document iterations to keep track of each redesign. Use your notebook paper to sketch ideas, document iterations and any measurement and/or calculations.
- It's also important to showcase the fact that there can be multiple solutions to the same problem. **There's no one "right" solution.**

This Challenge's Design Process

- Divide into your teams from yesterday
- Review the challenge and criteria & constraints
- Brainstorm possible solutions (sketch while you brainstorm!)
- Research design options and update design
- Choose your best solution and begin building
- Test your dam, then redesign until solution is optimized
- Reflect as a team and debrief as a class

Engineering a Dam!

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Share your initial designs and discuss challenges that you might face tomorrow.

Day 3

Plan, Build, and Test

5 minutes: Make changes to your design and plan what materials you will need

35 minutes: Build your dams

10 minutes: Perform initial tests pouring water into your reservoir. Then clean up and reflect on what changes need to be made tomorrow.

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Day 4

How do engineers know if a dam will work?

How do engineers know if a dam will work?

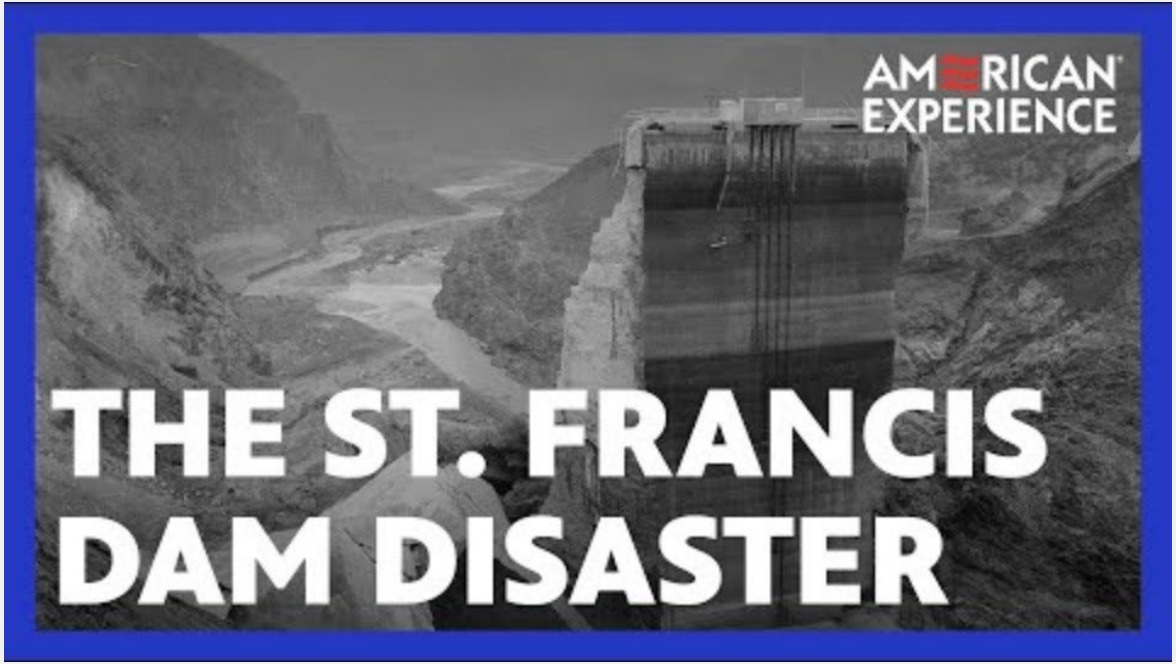
Engineers perform various tests and construct computer models to check if their designs and final construction will be effective at holding back water.

Smaller systems often have **leak tests** where engineers fill the structure with water to see if any sections are leaking or may present issues in the future.

You will perform leak tests on your model dams by testing how well your reservoir can hold the required 5 cups of water!

What could happen if a dam fails?

The St. Francis Dam Disaster



Final Dam Testing!

Model Dam Tests

Water Release Test

- Slowly pour 5 cups of water into your reservoir
- Time your dam to see how long before leaks or failure
- Observe and record how much water comes through
- Test your controlled release after 2 minutes
- Observe and record if the mechanism is successful.

Erosion Test

- Slowly pour 7 cups of water to simulate a flood or heavy rain
- Time your dam to see how long before leaks or failure
- Observe and record if the dam is able to withstand the pressure or if it erodes away

Redesign and improve

If time allows:

Redesign and improve your dam structures with remaining materials.

Perform the tests again and record any changes in performance.

Discussion of results

Which designs worked best? Why?

Did your designs improve after you made changes?

If you had another iteration, what would you have done differently?

What real-world factors might have impacted a real dam?

What impacts could your dam have had on the environment?

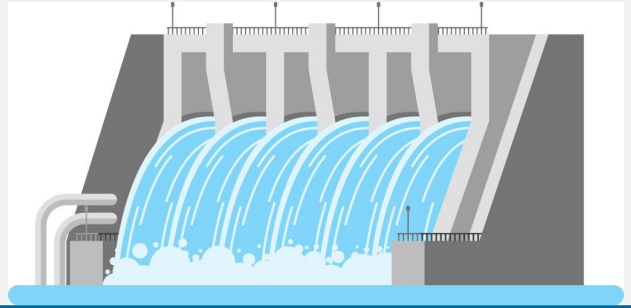
How do engineers balance the benefits and risks of dams?

Takeaways

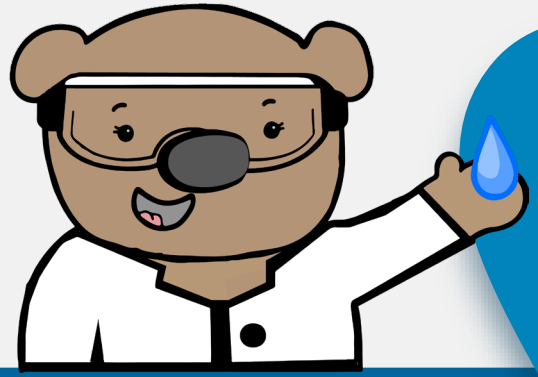
What was your favorite thing you learned this week?

What is something new you learned about dams?

Can you see yourself becoming an environmental engineer in the future?



Thanks for learning about the power of dams with us!

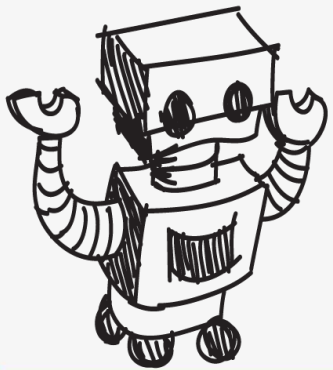


Additional Resources

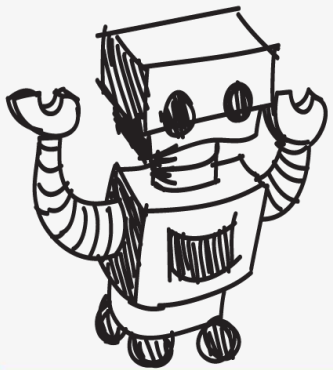
Consider...

- Before you get started building, consider showing sharing and discussing the information from the PBS Building Big - All about Dams website http://www.pbs.org/wgbh/buildingbig/dam/index.html.

Engineering Design Process



Vocabulary



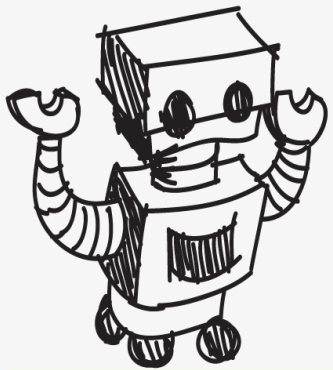
Vocabulary

- Criteria: Conditions that the design must satisfy like its overall size, etc.
- Dam: A barrier constructed to hold back water and raise its level, forming a reservoir used to generate electricity or as a water supply
- Engineers: Inventors and problem-solvers of the world. Twenty-five major specialties are recognized in engineering (see infographic).
- Engineering Design Process: Process engineers use to solve problems.
- Engineering Habits of Mind (EHM): Six unique ways that engineers think.
- Flow: How a fluid, gas, or electricity moves along steadily and continuously in a current or stream.

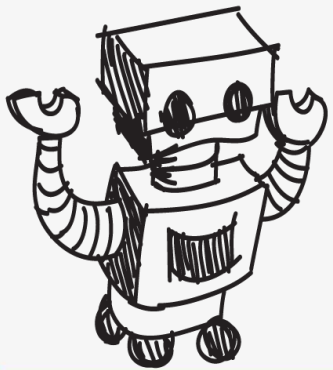
Vocabulary

- Hydroelectric power plants: Produce power using the flow of water that is then delivered to homes and businesses via power line
- Iteration: Test & redesign is one iteration. Repeat (multiple iterations).
- Prototype: A working model of the solution to be tested.

Reflect & Debrief



Dig Deeper



Dig Deeper into the Topic

Internet Connections

- Building Big - All About Dams (www.pbs.org/wgbh/buildingbig/dam)
- GeoGuide: Dams (geoknow.net/pages/dams.html)
- Hydroelectric Power (www.eia.doe.gov/kids/energy.cfm?page=hydropower_home-basics)
- Tennessee Valley Authority (www.tva.gov/Energy/Our-PowerSystem/Hydroelectric)

Dig Deeper into the Topic

Recommended Reading

- Dams (Library of Congress Visual Sourcebooks) (ISBN: 978-0393731392)
- Hoover Dam: An American Adventure (ISBN: 978-0806122830)
- Hydroelectric Power: Power from Moving Water (ISBN: 978-0778729341)

Writing Activity

Write a paragraph about how dam construction can impact the environment. What are the ethical considerations an engineering team must consider when constructing a dam or any other structure that has an impact on the environment.