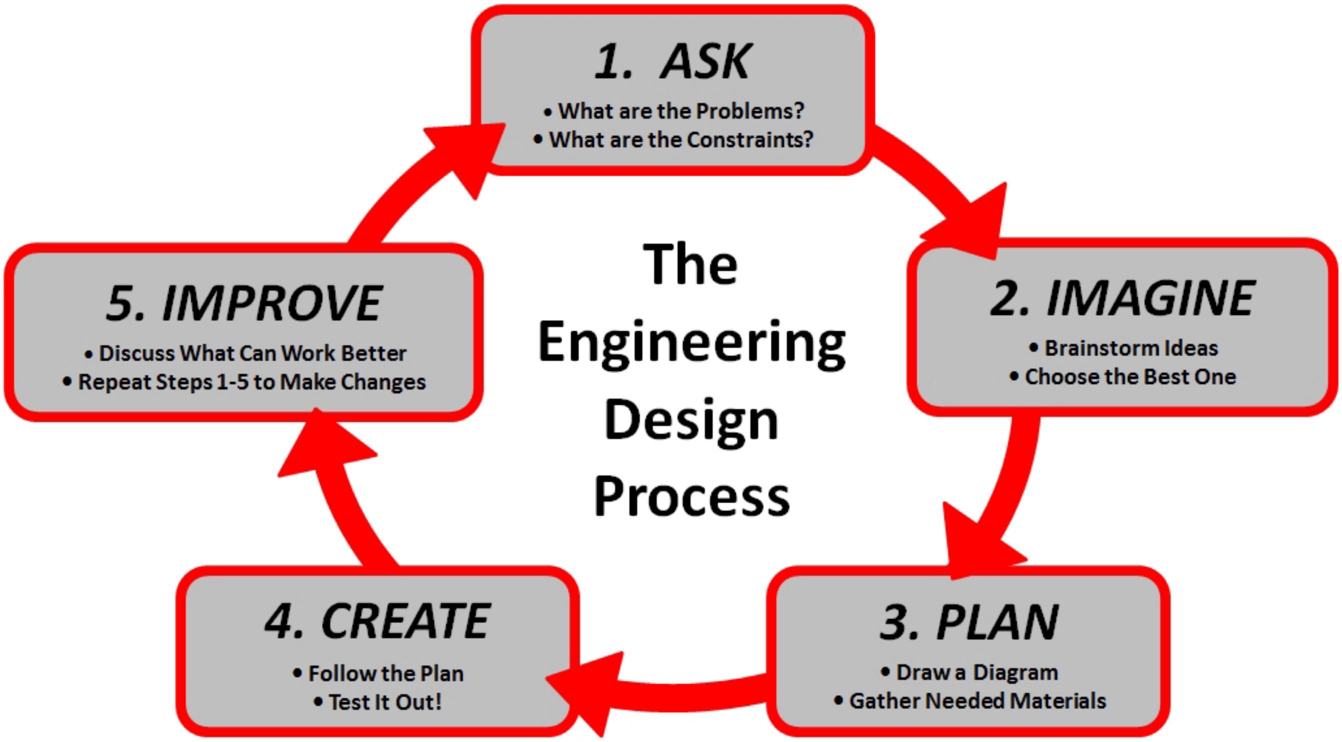

1. ASK
• What are the Problems?
• What are the Constraints?
2. IMAGINE
• Brainstorm Ideas
• Choose the Best One
3. PLAN
• Draw a Diagram
• Gather Needed Materials
4. CREATE
• Follow the Plan
• Test It Out!
5. IMPROVE
• Discuss What Can Work Better
• Repeat Steps 1-5 to Make Changes
The Engineering Design Process

Video Analysis Sheet **Name**______________________________

After watching each video, respond to these questions.

1. Hama Waterwheels, Syria

What difference did this engineering project make?

What problem did it solve?

2.Pont du Gard, France

What difference did this engineering project make?

What problem did it solve?

3. Panama Canal, Panama

What difference did this engineering project make?

What problem did it solve?

4.Mohenjo Daro, Pakistan

What difference did this engineering project make?

What problem did it solve?

5. Chand Baori, Jaipur, India

What difference did this engineering project make?

What problem did it solve?

6. Chunnel, English Channel

What difference did this engineering project make?

What problem did it solve?

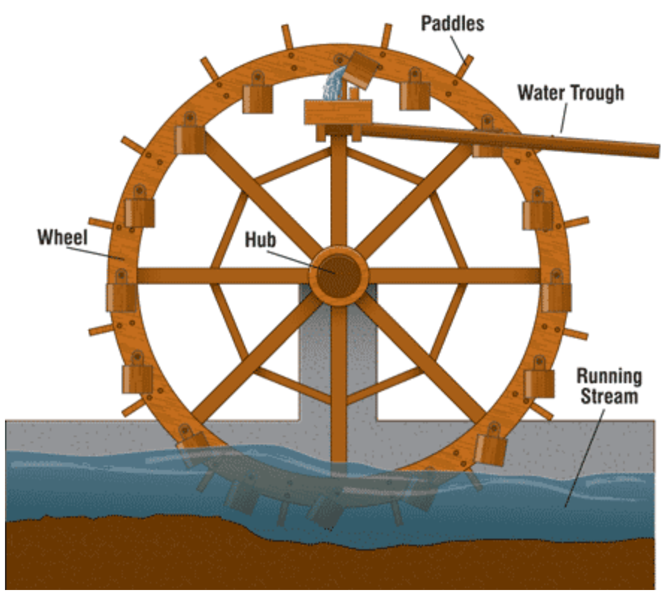
Engineering that Made a Difference

Hama, Syria
Latitude: 35º 8’ 7” North
Longitude: 36º 45’ 11” East

The name *noria* means “wheel of pots” in Arabic. For centuries the *norias* of Hama lifted water to small aqueducts to irrigate the fields surrounding this Syrian city. The Norias of Hama date from the twelfth century and were enlarged in the fourteenth century. At one point in the medieval era there were over thirty waterwheels in the city drawing water from the Orontes River.

Each of the wheels can be up to 70 feet in diameter. The river water is channeled into a trough on the wheel. This flow then forces the wheel to turn, and wood boxes raise the water upwards. At the top of the wheel, there is a channel in which the water is poured. The water is then led by gravity along a series of aqueduct channels. It was distributed to houses or farms in Hama. Getting to use the water was worked-out so that the water could be shared

Trough: a channel for carrying water
Channel: ditch for carrying liquid

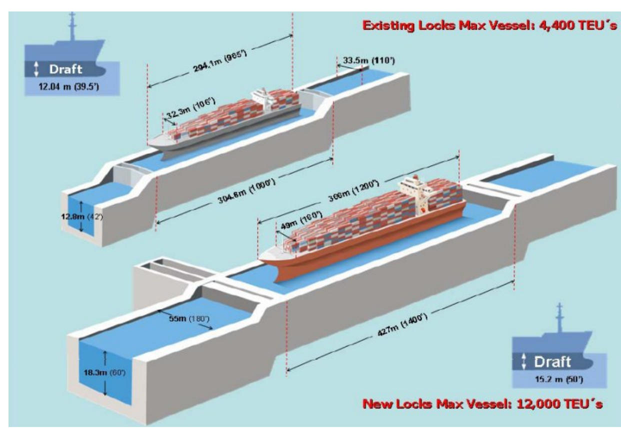


Engineering that Made a Difference

Panama Canal Zone
Latitude: 9° 04’ 48” North
Longitude: 79°40’ 48” West

The 48 mile long Panama Canal connects the Atlantic Ocean (via the Caribbean Sea) to the Pacific Ocean. The canal crosses the Isthmus of Panama and is a key passage for international trade. The Panama Canal made it possible for ships to travel between the Atlantic and Pacific Oceans in half the time previously required. One of the largest and most difficult engineering projects ever undertaken, the Panama Canal made it possible for ships to travel between the Atlantic and Pacific Oceans in half the time previously required. The shorter, faster, safer route to the United States west coast and to nations in and along the Pacific Ocean allowed those places to become more prosperous. There are locks at each end to lift ships up to Gatun Lake (85 feet above sea-level). The current locks are 110 feet (33.5 m) wide. A third, wider lane of locks is being built. France began working on the canal in 1881, but had to stop because of engineering problems and high mortality due to a tropical disease carried by the mosquito The French effort ended in 1890 after losing an estimated 22,000 lives and reportedly spending $287,000,000. The United States later took over the project and took a decade to complete the canal in 1914.

Prosperous: rich
Mortality: death rate
Decade: 10 years



ARIZONA GEOGRAPHIC ALLIANCE

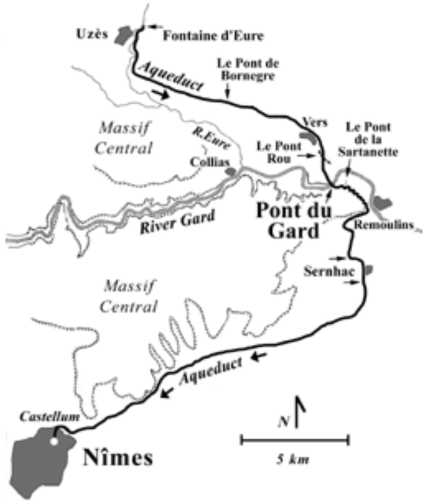
Engineering that Made a Difference

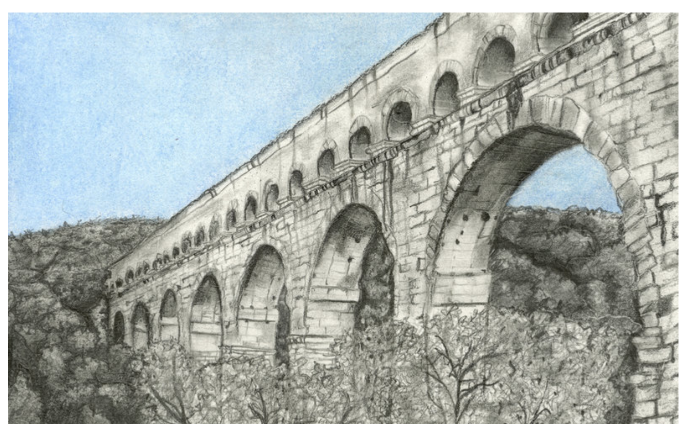
Avignon, Southern France
Latitude: 43o 56’ 50” North
Longitude: 4o 32’ 8” East

Pont du Gard is a three-level stone aqueduct crossing the Gardon River Valley, west of Avignon. It was built over 2000 years ago by the Romans. The aqueduct crosses the Gard River from Uzes to the city of Nimes. It stands almost 164 feet high and has three levels. The aqueduct was designed to carry 40,000 gallons of water daily. The entire length of the aqueduct is just over thirty-one miles. A road bridge was added to the structure in 1743 and used until 1996. The site is now well maintained and a very popular tourist attraction.

The Roman architects and hydraulic engineers who designed this bridge, created a technical and artistic masterpiece. The aqueduct was built entirely without the use of mortar. The stones that can weigh up to 6 tons each are held together with iron clamps. The masonry was lifted into place by block and tackle with a massive human-powered treadmill providing the power for the winch. A complex scaffold was erected to support the aqueduct as it was being built. It is believed to have taken about three years to build, employing between 800 and 1000 workers.

Clamps: used to hold things in place
Block and tackle: a device for raising heavy objects





ARIZONA GEOGRAPHIC ALLIANCE

Engineering that Made a Difference

Mohenjo-daro, Pakistan
Latitude: 27° 19’ 45” North
Longitude: 68° 08’ 20” East

Mohenjo-daro, “Mound of the Dead” is an archeological site in the province of Sindh, Pakistan. Built around 2600 BCE, it was one of the largest settlements of the ancient Indus Valley civilization, and one of the world's earliest major urban settlements. Mohenjo-daro was built in the middle of the flood plain of the Indus River Valley. In terms of size and importance, Mohenjo-daro is like the civilizations of ancient Egypts, Mesopotamia, and Crete. It was abandoned in the 19th century BCE, and was not rediscovered until 1922.

Mohenjo-daro is considered the most advanced city of its time with sophisticated civil engineering and urban planning. Mohenjo-daro had the world’s first sewer system. Individual households or groups of households obtained their water from smaller wells. Some houses had bathrooms and toilets that were connected to the system that carried away waste. One building had an underground furnace possibly for heating bath water, and a canal system provided a reliable source of water for growing wheat and barley

Abandoned: to leave
Flood plain: low land that is easily covered by water
Sewer: channel or pipe to carry away wastewater

ARIZONA GEOGRAPHIC ALLIANCE

Engineering that Made a Difference

Chand Baori- Jaipur, India
Latitude: 27º 00’ 72” North
Longitude: 76º 60’ 68” East

Chand Baori was constructed by King Chanda between 800 and 900 CE. Its 3500 narrow steps in 13 stories extend 100 feet into the ground, making it one of the deepest (and largest) stepwells in India. This construction of stairs and steps ensured that the Rajput people had access to water at any time of the year and from all sides. Stepwells allow people to reach the ground water. They are also easier to maintain and manage. The reasons for building such an elaborate stepwell is not fully clear. Some believe it was used as a water harvesting site as well as a place for social gatherings and religious ceremonies

The structure of Chand Baori was intended to conserve as much water as possible in a very arid area. At the bottom of the well, the air remains 5-6 degrees cooler than at the surface. Chand Baori was also used as a gathering place for local families during periods of intense heat

Intense: high
Conserve: to save or use as little as possible

Engineering that Made a Difference

Channel Tunnel "Chunnel"   England to France
Folkestone Latitude: 51° 5' 49.5" North   Longitude: 1° 9' 21" East
Coquelles Latitude: 50° 55' 22" North   Longitude: 1° 46' 50.16" East

The Chunnel is a 31.4 mile undersea rail tunnel linking Folkestone, Kent, in the United Kingdom with Coquelles, Pas-de-Calais, in northern France. The Chunnel runs beneath the English Channel at the Strait of Dover. At its lowest point, the Chunnel is 250 feet under the water. The Channel Tunnel is the longest undersea tunnel in the world.

Construction began on the Chunnel in 1988, and it opened in 1994. It is built of steel and concrete and cost $21 billion to build. It took three years for tunnel boring machines from France and England to chew through the chalky earth and meet hundreds of feet below the surface of the English Channel. Many of the tunnel-boring machines used on the Chunnel were as long as two football fields and capable of boring 250 feet a day.

The Channel actually consists of three tunnels. Two of the tubes are full sized for rail traffic. In between the two train tunnels is a smaller service tunnel that serves as an emergency escape route. There are also several "cross-over" passages that allow trains to switch from one track to another. Just one year after the Chunnel opened, this engineering design was put to the test. Thirty-one people were trapped in a fire that broke out in a train coming from France. The design worked. Everyone was able to escape through the service tunnel.

The tunnel carries high-speed passenger trains, vehicle transporters, and freight trains. Today, trains roar through the tunnel at speeds up to 100 miles per hour and it's possible to get from one end to the other in only 20 minutes!

Freight: goods that are being moved
Tunnel: underground passage
Boring: digging

ARIZONA GEOGRAPHIC ALLIANCE

Reading Analysis Sheet

Pick one of the six locations you have read about. Answer the five questions below using details from the video or text. Use correct spelling, capitalization and punctuation.

Location ___________________________________ Student Name____________________

1. What engineering problem needed to be defined/solved? (5 pts)

2. What group(s) of people did this technology benefit? (5 pts)

3. What were the geographic challenges? (5 pts)

4. What knowledge and skills were needed to complete a successful project? (5 pts)

5. What changes might you have made in this design (5 pts)

6. correct spelling, capitalization, and punctuation (10 pts)

ARIZONA GEOGRAPHIC ALLIANCE

Reading Analysis Sheet Answer Key

Location___Hama Waterwheels______________

1. What engineering problem needed to be defined/solved? 5 pts) how to irrigate fields from the Orontes River.

2.What group(s) of people did this technology benefit? (5 pts) households and farmers

3. What were possible geographic challenges? (5 pts) how to move the water in this terrain, what if there is a shortage in the amount of available water

4. What knowledge and skills were needed to complete a successful project? (5 pts) creating clay pots and attaching to a wheel, designing wheels, math to figure out 360 degrees, building aqueducts, making iron into parts

5 What changes might you have made in this design? (5 pts) (range of answers)

Location __Pont du Gard________________

1. What engineering problem needed to be defined/solved? 5 pts) how to construct the aqueduct over the river and still allow boats to travel on the river, how to get water to flow

2 What group(s) of people did this technology benefit? (5 pts) It was designed to carry 40,000 gallons of water daily for the city of Nimes, households and farms.

3. What were possible geographic challenges? (5 pts) building in a moving river, allowing for river traffic, getting building materials from local area,

4. What knowledge and skills were needed to complete a successful project? (5 pts) math skills, how to construct arches, how to support three levels of arches. how to hold the aqueduct together without mortar, ability to design parts that work.

5 What changes might you have made in this design (5 pts) (range of answers)

Location Panama Canal______________________

1. What engineering problem needed to be defined/solved? 5 pts) how to shorten the length of time and distance to sail between the Atlantic and Pacific

2. What group(s) of people did this technology benefit? (5 pts) The US West coast and nations along the Pacific, international trade

3. What were possible geographic challenges? (5 pts) locks were made to raise the water and float the ships, route picked because it was a short distance to channel, disease caused by the mosquitoes (tropical climate)

4. What knowledge and skills were needed to complete a successful project? (5 pts) engineering skills to create the lock system, math skills, surveying skills, science skills in the form of mosquito containment and care for malaria

5 What changes might you have made in this design (5 pts) (range of answers)

Location Mohenjo Daro. Pakistan_________________

1. What engineering problem needed to be defined/solved? 5 pts) how to develop covered drains for human waste and household waste, how to lay out an organized and efficient city, water for crops
2. What group(s) of people did this technology benefit? (5 pts) The entire community

3. What were possible geographic challenges? (5 pts) sat on a river floodplain so they would have to plan for flooding, is soil of the right composition for building, getting a reliable source of water, elevation of land so sewers would work

ARIZONA GEOGRAPHIC ALLIANCE

4. What knowledge and skills were needed? (5 pts) there were probably no models to build from. innovative engineering design and planning, skill in building bricks and canals, understanding of how to build a furnace underground

5 What changes might you have made in the design? (5 pts) (range of answers)

Location _____Chand Baori Jaipur,India____

1. What engineering problem needed to be defined/solved? 5 pts) how to create a stable location for water retrieval and for community gathering
2. What group(s) of people did this technology benefit? (5 pts) Families
3. What were possible geographic challenges? (5 pts) soil composition, how do you dig a well that deep, here do you get the stones to build the steps, what if the water level drops
4. What skills were needed? (5 pts) Incredible math skills to work out the formula for laying the steps in patterns and angles, engineering skills to keep the site stable, skilled stonemasons

5 What changes might you have made in this design? (5 pts) (range of answers)

Location Chunnel/English Channel____

1. What engineering problem needed to be defined/solved? 5 pts) how to efficiently move goods and people between the island nation of England and the European continent
2. What group(s) did this technology benefit? (5 pts) The economies of both nations--England and France, European markets, passengers who want a quick route over the English Channel, transportation of goods not available in one location or the other
3. What were possible geographic challenges? (5 pts) working under the English Channel, working with chalky soils, hundreds of feet below the surface, mapping the route so Chunnel ends up in correct locations
4. What knowledge and skills were needed to complete a successful project? (5 pts) engineering of special boring machines. knowledge of concrete and steel underwater construction, surveying, safety considerations building Chunnel and later,

5 What changes might you have made in this design? (5 pts) (range of answers)