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History of Engineering and Technology

Lecture 3: Engineering in the ancient era.

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Ancient Engineering
(~8000 BCE→~500 CE)

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- The Mesopotamia civilization.
- The Sumerian civilization.
- Large engineering construction projects in Egypt and Sumer.
- Other civilizations (China, Minoan and Hittite).
- The Greek civilization.
- The Roman civilization.

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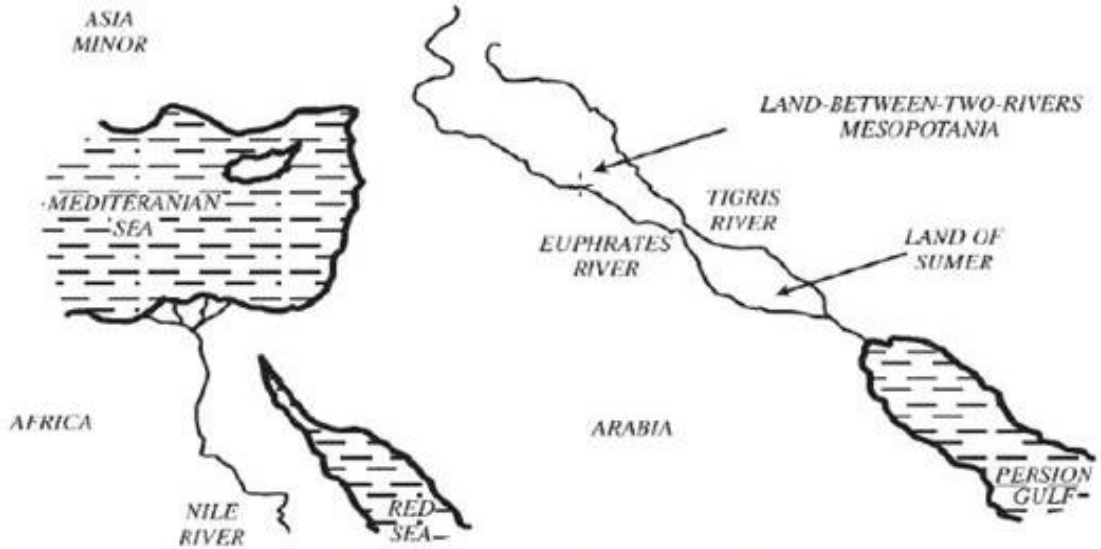
The Mesopotamia civilization

The Mesopotamia civilization

- It is estimated that by about ***8000 BCE***, nearly 500,000 people inhabited ***Mesopotamia*** (The land between the two rivers).



Invention of Tools

THE SCRATCH PLOW

The scratch plow— a vee-shaped tree branch for pushing and pulling — to loosen the top 3–5 cm of soil for planting

Invention of Tools

SICKLES

Further, artifacts resembling sickles consisting of sharp-edged flint inserted in slots of curved wood have been found as evidence of increasingly efficient tool development for harvesting.

Invention of Tools

POTTERY

During this Agricultural Revolution, the first thermally-induced material transformation was discovered by about ***5000 BCE*** when it was found that campfire heat would irreversibly harden the clay to yield ***pottery***.

Invention of Tools

ADOBE BRICK

It was also discovered that if ***straw*** is mixed with ***moist clay*** and the resultant blob molded into a more regular shape and allowed to sundry, an ***adobe brick*** useful for wall construction resulted

$$N(t)\left\{\begin{matrix}clay,\ fiber,\\ solar,\ heat\end{matrix}\right\} \rightarrow E(t)\left\{\begin{matrix}mixing,\ shaping,\\ fire\ heating\end{matrix}\right\} \rightarrow D(t)\left\{\begin{matrix}pottery\\ brick\end{matrix}\right\}$$

Invention of Tools

MORTAR

This use of clay + straw + water adobe brick making, beginning about 5000 BCE, was soon followed by ***mortar*** consisting of ***sand*** and ***powdered limestone*** which, when mixed with ***water***, served both as ***wall plaster*** and ***brick bonding agent***.

The discovery of metal copper ornaments

- Further—one may imagine—when ***a charcoal fuelled fire happened to be located on some exposed copper ore***, a ***red-brown liquid flowed and when cooled formed little light-brown globule***. Thus, by accident and probably occurring repeatedly in different areas, ***smelting was discovered*** thereby establishing the specific primal progression

$$N(t)\{Cu\text{-}ores\} \rightarrow E(t)\{smelting, shaping\} \rightarrow D(t)\{copper\ ornaments\}$$

Bronze tools

- Development, however, did not end ***with copper smelting***. When this ***copper ore*** was accidentally mixed with a ***black tin ore*** in a draft-blown fire, a ***hard and chip-resistant new metal*** resulted as follows

$$N(t)\{Cu, Sn\} \rightarrow E(t)\{draft\ heating, shaping\} \rightarrow D(t)\{bronze\ tools\}$$

- This new metal could be cast and held a sharp edge very well providing therefore further material choices in the making of devices; it also introduced a new age, ***the Bronze Age***, beginning about 3500 BCE and thus following the Stone Age.

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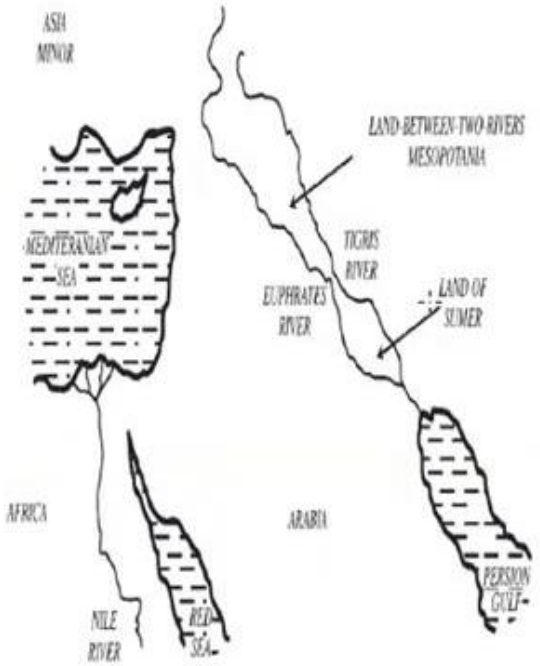
The Sumerians civilization

The Sumerians

- Beginning about ***4500 BCE***, a most significant series of developments occurred when a group of people called the ***Sumerians*** began settling in the lower reaches of the Tigris River and Euphrates River. These people possessed an ***interest in making ingenious devices***, in particular, ***improving pottery, weaving and developing kiln-fired pots and bricks.***

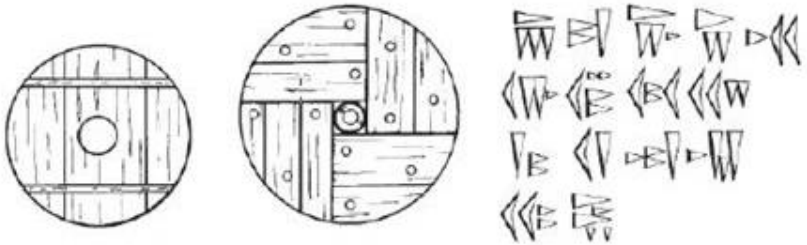


The Sumerians

- They were the first sufficiently organized people to begin ***erecting large ceremonial structures*** and ***improve agrarian productivity*** by the ***construction of stone and brick lined irrigation canals***.

- About ***3500 BCE***, ***settlements became larger*** leading also to the ***first evidence of city-states, large terraced buildings, and the appearance of rulers as priest-kings.***

Invention of Tools



$$N(t)\{wood\} \rightarrow E(t)\{shaping,\ assembling\} \rightarrow D(t)\{wheel\}$$

$$N(t)\{clay,\ reeds\} \rightarrow E(t)\{standardization,\ notation\} \rightarrow D(t)\{clay\ tablets\}$$

- establishing thereby a basic form of both

  Transportation Engineering and ***Information Technology***—about 5500 years ago.

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Large engineering construction projects in Egypt and Sumer.

Structures and symbols

Peoples of Sumer and Egypt produced some of the earliest large engineering constructions

	SUMER	EGYPT
IRRIGATION	• By 3500, ***irrigation channels*** exceeded 50 km in length. Some were made larger and deeper to provide limited storage • ***Stone dams*** were constructed to impound flood water for future use.	• Variation of land elevation was used to direct the Nile water. • Some clever devices were used to raise water like ***shadoof*** and ***Saquia*** (an animal powered vertical wheels with tilting water containers mounted along the rim).

Shadoof and Saquia

SHADOOF & SAQUIA

Large structures

SUMER	EGYPT
Summerian Ziggurats (26 m high, with a base of 60x70 m2) layers of stone with a shrine at the top.	Oversized brick and stone walled ***tombs*** and ***pyramids*** (150 m high with a base of 230x230 m2)

Sumerian Ziggurat (~3500 BCE)

Egyptian Pyramids (~2500 BCE)

	SUMER	EGYPT
ANCIENT ENGINEERS (BUILDERS)	2300 BCE GUDEA	2900 BCE IMHOTEP

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Other civilizations

China

- Another population cluster began about 2000 BCE, in the Yellow River Valley of present day ***China***. This population cluster eventually proved to be particularly influential for its early and significant discoveries: ***ink, ~2000 BCE; lodestone magnet, ~1000 BCE; paper, ~200 BCE; porcelain, ~500 CE.***

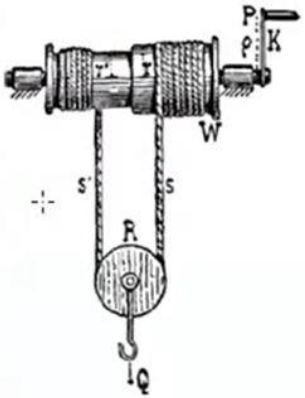
Minoan

- Minoan culture emerged on the island of Crete, about 2000 BCE. These Bronze Age Cretans developed a ***unique system of writing***, knew how to make ***bronze tools***, were skilled in the making of ***wooden ships*** and construction of ***stone buildings***, and were ***ruled by kings***. ***They even installed a system of indoor plumbing and sewage discharge.***

Hittite

The Hittite people residing in present-day eastern Turkey.
They were the first people who invented the coins.

The windlass (also known as a capstan) — first noted about 1400 BCE in the Middle East — is often judged to be next in importance to the wheel.



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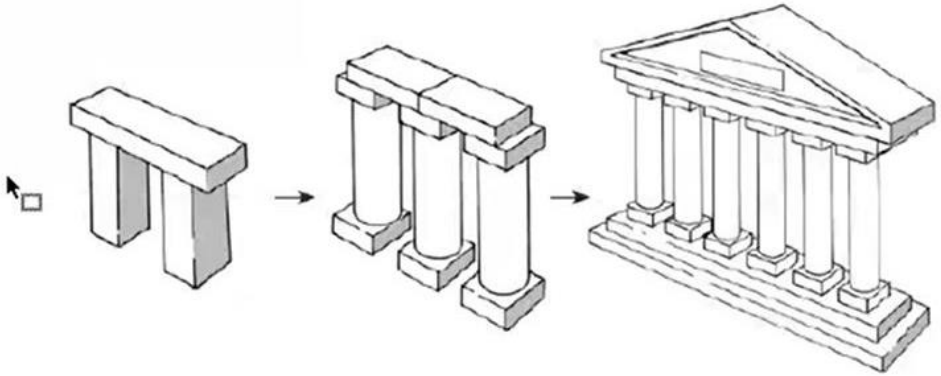
The Greek civilization

The Greek

During the time of the ***Greek Civilization (about 600 BCE)***, several important engineering developments emerged:

(a) Widespread ***iron smelting*** now replaced bronze for tools and weapons.

Greek Temples



(b) Emergence of ***good looking temples***, ***open-air theatres, marble and bronze sculptures, public squares, court yards, and impressive housing communities.***

Greek Ships

(c) Establishment of a ***powerful Greek navy*** with vessels characterized by single-sail, multi-tiered rowers, and a fore ram for piercing enemy ships

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The Romans civilization

Roads

To begin, Romans added a unique new feature to the practice of engineering: efficiency of large-scale and extended construction in support of military-political objectives.

(a) During their ~600 years of domination over the Mediterranean region and western Europe, they built and maintained a network of over 100,000 km of all-weather roads linking some 4000 towns and cities.

Colosseum and Pantheon

(b) Further, they built grand public structures such as the Colosseum in Rome holding 80,000 spectators—the largest structure of its kind in the world until the 1900s—and the Pantheon, the largest circular dome structure of its day.

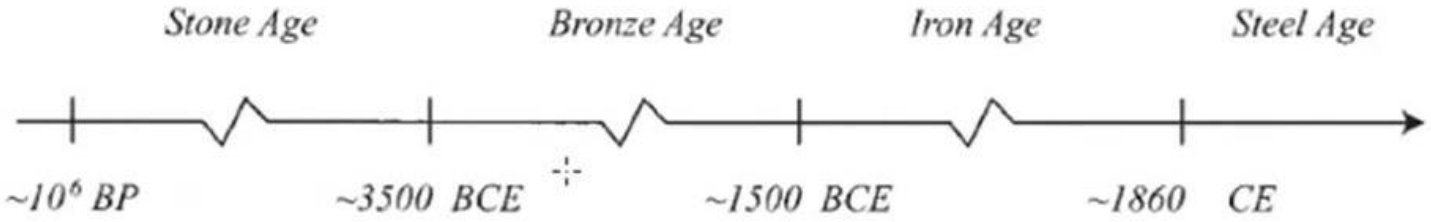
Aqueduct and Weaponry

Design evolution beginning with the Roman arch and leading to Roman viaduct/aqueduct structures of various length and multiple tiers.

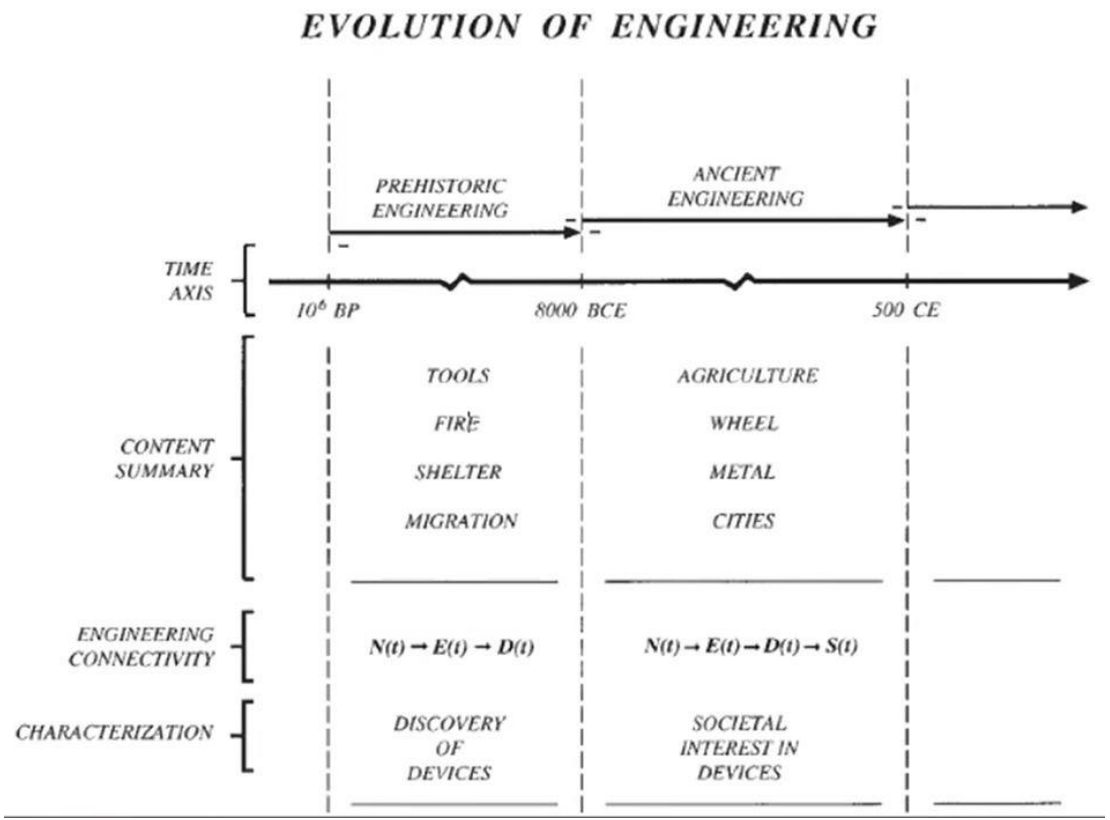
(c) Their bridges an aqueducts proved to be of remarkable endurance, many still standing as ruins and some even now still in use.

(d) Finally, they erected a diversity of walled defensive structures, improved on offensive and siege weaponry, and refined hand weapons and body armor.

Material-use evolution



Evolution of Engineering



Ancient Engineering (~8000 BCE→~500 CE)

Thank you !