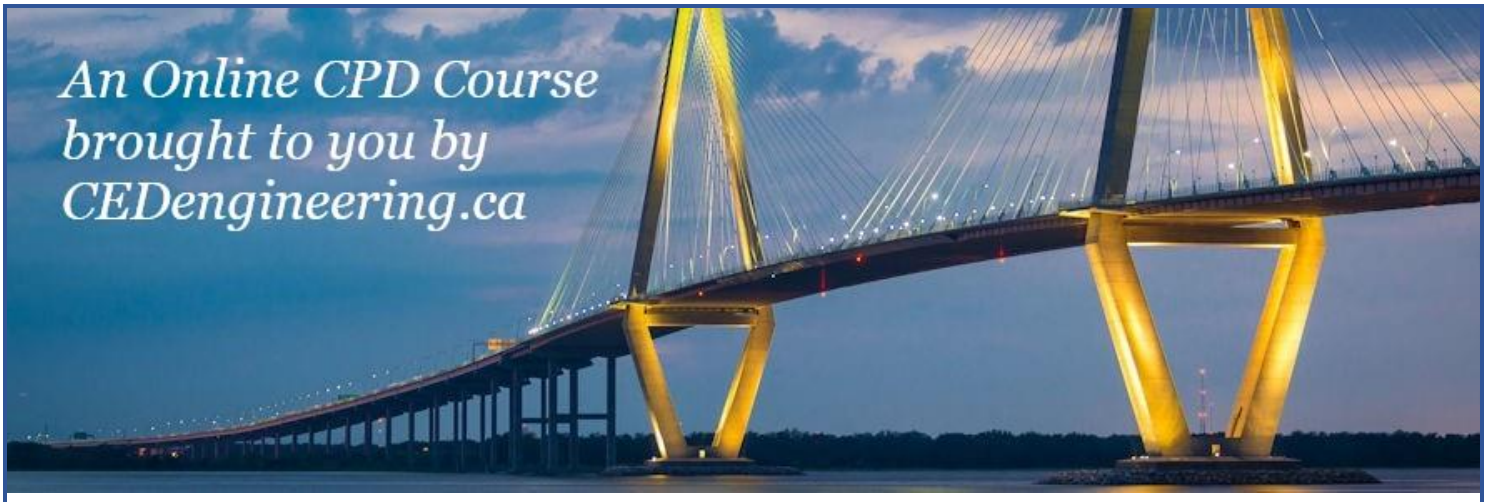

Greek Engineering

Course No: B03-015
Credit: 3 PDH

Robert Steelhammer, P.E.

Continuing Education and Development, Inc.

P: (877) 322-5800
info@cedengineering.ca

Table of Contents

Introduction

The ancient Greeks are often given credit for inventions that we use a variation of today. Greek architecture is apparent on many public buildings in the modern world. They adapted good ideas from other cultures to their own use. They excelled in mathematics and science and were far ahead of others. They excelled in poetry and theatre. Ancient Greece is considered the birthplace of democracy and Western philosophy.

The History and Government of Greece

Ancient Greece, also known as Hellas, was a civilization that existed in the northeastern Mediterranean. It existed from the Greek Dark Ages (12th to 9th Centuries BC) until the end of classical antiquity (600 A.D). It consisted of city-states that were of similar language and culture. These city-states were only unified officially for approximately 13 years, under the empire of Alexander the Great (336 to 323 BC), who had been tutored as a youth by Plato's student, Aristotle.

Ancient Greece consisted of the late Bronze Age and Greek Antiquity. Ancient Greece lasted from approximately 1200 BC until about 600 AD. To make it more understood, Ancient Greece has been divided into the following periods:

Greek Dark Ages, from 1100 BC to 800 BC
Archaic Period, from 800 BC to 490 BC
Classical Period, 490 BC to 323 BC
Hellenistic Period, 323 BC to 146 BC
Roman Greece, 146 B.C to 324 A.D

Traditionally, Ancient Greece was taken to begin in 776 BC with the first Olympic games. Many historians extend the term back to 1100 BC, with the beginning of the Greek Dark Ages. Ancient Greece is considered by many historians where Western Civilization was founded. Western philosophy from Socrates, Plato, and Aristotle came from Ancient Greece in the fifth and fourth centuries BC. Literature from Homer and Hesiod also came from Ancient Greece. Much of the mathematics we use came from Pythagoras, Archimedes, and Euclid. We got history from Herodotus. Democracy came from Ancient Greece. The Romans borrowed and developed many ideas from Ancient Greece.

The Minoan and Mycenaean Civilizations

The forerunners of the Ancient Greeks were the Minoans and the Mycenaeans. The Minoan Civilization began on the island of Crete. They existed from approximately 2700 BC to 1500 BC and were a dominant sea power in the Mediterranean. The culture was named for the ancient Cretan king Minos.

The Minoans developed a system of writing. It is known as Linear A and has not been deciphered. They also made advances in shipbuilding and King Minos was credited by ancient

historians as being the first to establish a navy, with which they conquered the Cycladic Civilization.

Most of what we know about the Minoans is from discoveries of large houses and palaces discovered during archeological digs. For example, from the Knossos archeological site. The Minoan civilization exploited groundwater by developing springs and wells. They also collected rainwater in cisterns. They developed a piping system using terracotta pipes for their water supply system. They also developed a toilet and sewer system. They developed sanitary and storm sewers.

The Minoans were likely conquered by the Mycenaeans. The final cause of the Minoans fall was the eruption of the volcano on the nearby island of Thera (present-day Santorini) between 1650 and 1550 BC. The isle of Crete was deluged by the resulting tsunami, destroying the villages on the island. This eruption and tsunami is frequently cited as Plato's inspiration for creating his myth of the lost city of Atlantis.

The Mycenaean Civilization existed from approximately 1900 BC to 1100 BC. It is commonly cited as the beginning of the Greek culture. Little is known about the Mycenaeans except what is found from archeological finds, as well as Homer's account of their war with Troy in the Iliad. They developed the writing systems known as Linear B, which is an early form of the Greek language that descended from the Minoan Linear A. The Mycenaeans seem to be influenced by the Minoans of Crete in their worship of gods.

The Mycenaean Civilization either died off or was destroyed by 1100 BC. Some have claimed that the Mycenaean Civilization was destroyed by a Doric (Dorian) Greek invasion. The archeological evidence has been inconclusive. Tablets of Linear B found only contain lists of bartered or stocked goods.

Greek Dark Ages (1100-800 BC)

The Greek Dark Ages was the period in Greek history from the Dorian invasion and end of the Mycenaean civilization around 1100 BC to the rise of the first Greek city-states in the ninth century BC. The period was known as the Dark Ages because of the lack of written documentation or history. The end of the Greek Dark Ages came with the epics of Homer and the earliest writings in the Greek alphabet.

The collapse of the Mycenaean civilization happened at the same time as the fall of the Hittite and Egyptian empires. Kings ruled during this period, until they were replaced by an aristocracy. Warfare shifted from a cavalry focus to an infantry focus. Iron replaced bronze as the metal of choice for tools and weapons, due to its being cheap and easily available.

Archaic Greece (800-490 BC)

Greece began to emerge from the Dark Ages in the eighth century BC. Greeks adopted the Phoenician alphabet, which they modified to create the Greek alphabet. Written records began to appear in the ninth century BC. Greece was composed of many small communities that were self-governing. These were known as city-states (polis) and it was the most important political unit. This was a reality that was created by geography of mountains and islands.

The Olympic games began in 776 BC. They were held once every four years to honor the god Zeus. The earliest games were one day long and consisted of running and wrestling. A running event called the "stade" was a 630 foot race on foot was an early event. Chariot races and horse races were added to the events in the seventh century BC. Since the city-states were often at war, a truce was called before the Olympics. This allowed the participants to safely travel to Olympia, on the western Peloponnese peninsula, for the games. The last Olympic games in ancient Greece were held in 393 AD.

During this period, tyrants rose to power in some Greek states. One famous one was in Corinth around 657 BC when Cypselus overthrew the ruling family. There was a failed coup attempt around 636 BC, led by Cylon of Athens. Draco was appointed in 621 BC to establish a legal code. In 594 BC, the Athenian legislator Solon was given the authority to enact a set of reforms attempted to balance the power between the rich and the poor. He canceled debts and released peasants from serfdom. He also introduced coinage to Athens, as well as a system of weights and measures. The tyrant, Pisistratus, ruled in the middle of the sixth century BC. His son Hippias inherited the position after his death in 527 BC. Many democratic reforms were carried out by Cleisthenes towards the end of the sixth century BC.

The political system in Sparta was a little different from Athens. Sparta had a system with two kings, a council of elders, and five ephors.. This system developed over the eighth and seventh centuries BC. The constitution was established by Lycurgus, the legendary lawgiver.

In the sixth century BC, The Greek city-states started forming more formal relationships with each other. These were different than previous relationships where the individual ruler relied on personal relationships with rulers and elites of the other city-states. Sparta built several alliances towards the end of the archaic period. This included the Peloponnesian League with Corinth, Elis, and Megara. This isolated Messenia and gave Sparta a better position against Argos. Other notable alliances in the sixth century BC include Elis and Heraea in the Peloponnese, and between the Greek colony of Sybaris and its allies with the Serdaioi.

Greece adopted many cultural elements from the orient, due to its location close to the Neo-Assyrian Empire.

Archaic Greece was characterized by introducing republics, instead of monarchies. One example is Athens, that developed its democratic system.

Classical Greece (490-323 BC)

Classical Greece was characterized by the city-state. The city-state was known as the polis and it was the basic unit of politics. Theoretically, each polis was politically independent. In practice, some were subordinate to or totally dependent on others.

The Classical Greek world was shaped two major wars. The first was the Persian Wars. They occurred between 499 to 449 BC. In 499 BC, the Greek cities of Ionia revolted against the Persian Empire. They were led by the city of Miletus, but were supported by Athens and Eretria. Darius I (Darius the Great) launched a Persian invasion of Greece as revenge, after the revolt was quashed in 494 BC. The Athenians and their Plataen allies defeated the Persians at the Battle of Marathon and the Persian fleet retreated. The Battle of Himera happened at the same time where the Tyrant of Syracuse, Gelon, defeated the Carthaginian invasion.

In 492 BC, The Persian general Mardonius led an army across the Hellespont and reconquered Thrace and added Macedonia. His purpose was to take revenge on the mainland Greeks, but that failed when his fleet was destroyed by a storm near Mount Athos. Darius sent another fleet in 490 BC directly across the Aegean Sea to control Athens. The fleet destroyed the city of Eretria. The fleet then landed and faced the Athenian army at Marathon. The Athenian army won this battle. Pericles started the building of the Acropolis and spoke a eulogy for the men who died at the Battle of Marathon.

The Persians tried again ten years later when Darius' son Xerxes launched an invasion in 480 BC. The northern and central city-states submitted to the invading Persian forces. An alliance of 31 city-states that included both Athens and Sparta was determined to defeat the Persian invaders. Greek Sicily was invaded by the Carthaginians around this same time. It was in 480 BC that the first major battle of this invasion was fought at Thermopylae, where Greeks that were led by 300 Spartans, protected a mountain pass for several days against a much larger Persian force. The Persians were defeated with a naval victory at Salamis and land victory at Plataea in 479 BC.

There was a continuation of the alliance against Persia. Initially the alliance was led by the Spartan Pausanias. Athens founded the Delian League, which was an alliance of city-states, in 477 BC. Its purpose was to defend Greece from more Persian attacks and deter the Persians. In the initial time period, each city in the League would contribute ships and soldiers to an army in the common cause of the League. Later, Athens allowed the smaller cities to contribute money for their share of the ships. They allowed for the punishment of member city-states that attempted to secede from the League. After the treasury of the League was moved from Delos to Athens, it gained the pejorative name of the Athenian Empire, due to the control Athens had over the League.

In 458 BC, a war broke out between the Peloponnesian League and the Delian League. The Peloponnesian League was comprised of Sparta and its allies. The fight ended up a stalemate and they signed a peace treaty in 447 BC. Peace lasted until 431 BC.

The Peloponnesian War

The Peloponnesian War began in 431 BC after relations between Athens and Sparta again declined. It began with a dispute between the cities of Corcyra and Epidamnus. Corinth was an ally of Sparta in the Peloponnesian League. They intervened on the side of Epidamnus. Athens prevented Corinth from landing on Corcyra. This was at the Battle of Sybota. They also laid siege to Potidaea. The Megarian decree forbade any commerce with a close ally of Corinth or Megara. The Corinthians sought aid from Sparta, who declared the treaty had been violated.

The first stage of the Peloponnesian war known as the Archidamian War (Spartan king Archidamus II). This part of the war lasted until 421 BC, when the Peace of Nicias was signed. The Athenian general Pericles recommended fighting a defensive war. This was to avoid having a battle with the forces of Sparta. Athens had a powerful navy, but Sparta had superior land forces. A defensive war meant that Athens would endure regular sieges by the Spartans. In 430 BC, Athens had a plague that killed approximately a quarter of its people. One of the casualties of the plague was Pericles, who died in 429 BC. With the death of Pericles, there was a shift inpower to a less conservative base. Athens then went on the offensive, instead of fighting a defensive war. In 425 BC, Athens captured 300-400 Spartan soldiers at the Battle of Pylos. The forces of Athens suffered defeats at Delium in 424 BC and Amphipolis in 422 BC. The first stage of the war ended with the Peace of Nicias in 421 BC. Sparta recovered its solders and Athens recovered the city of Amphipolis.

The peace under the Peace of Nicias lasted seven years. In 415 BC, the second stage of the Peloponnesian War began. Athens started on a Sicilian Expedition in Magna Graecia to support its ally in Segesta and conquer Sicily. Segesta was being threatened by Syracuse, a Spartan ally in Sicily. Sparta was reluctant to help Syracuse at first. This changed after the Athenian general Alcibiades defected to the Spartan cause after being accused of grossly impious acts. Alcibiades had originally argued for the Sicilian Expedition. After he defected, he convinced the Spartans that they could not allow Syracuse to be under control of Athens. The Athenians were defeated.

After the Athenians were defeated in Sicily, the Athens Ionian territories rebelled. The rebellion was supported by Sparta, as Alcibiades advised. In 411 BC, there was an oligarchical revolt in Athens. The Athenian navy did not accept the change and continued fighting in the name of Athens. Alcibiades had been forced to abandon the Spartan cause after seducing the wife of Agis II (Spartan king). He was recalled to the Athenian navy and put in charge. He reconquered the lost territory when the oligarchy in Athens collapsed.

Alcibiades was replaced in 407 BC after his naval defeat at the Battle of Notium. The Spartan general Lysander had bolstered the naval power of his city. In 406 BC, Athens won the Battle of Arginusae. Bad weather prevented the Athenians from rescuing their sailors. About a year later, Lysander followed with defeating the Athenians at the Battle of Aegospotami. The Athenian fleet was nearly destroyed and Athens surrendered a year later, which ended the Peloponnesian War. This began a period of Spartan domination in Greece after Lysander installed a pro-Spartan government in Athens in 404 BC. The pro-Spartan government known as the Thirty Tyrants installed by Lysander lasted a year.

The time-period from 400-330 BC is often referred to as the Late Classical Period. There was a lot of discontent with the Spartan dominance from Athenian as well as former Spartan allies. This discontent led to the Corinthian War of 395 BC to 387 BC. This war weakened the military power of Sparta. Athens, Thebes, Corinth, and Argos were backed by the Achaemenid Persian Empire. The war did not end Spartan dominance.

In 371 BC, the city-state of Thebes defeated Sparta at the Battle of Leuctra. The Spartan king Cleombrotus I was killed. Thebes then invaded Laconia. The Theban victories against Sparta led to the independence of Messenia. Sparta and Athens eventually joined forces against Thebes but were defeated in 362 BC at the Battle of Mantinea. After the Battle of Mantinea, there was not a dominant major city-state. Eventually the power dominance came to Macedon under Philip II. In 338 BC he defeated a Greek alliance during the Battle of Chaeronea. He formed the League of Corinth, uniting Greek forces under Macedonian leadership. He had planned an invasion of Persia, but he was assassinated in 336 BC.

Philip II's son, Alexander the Great, began a campaign to invade Persia in 334 BC. He defeated Darius III at the Battle of Issus in 333 BC, thus conquering Persia. Alexander the Great proclaimed himself the King of Asia after the Battle of Gaugamela in 331 BC. He then led expeditions to Bactria and India in 329 BC. He was undefeated in battle. He had plans to invade Arabia and North Africa, but these plans were stopped by Alexander's death in 323 BC.

Hellenistic Greece (323-146 BC)

The death of Alexander the Great in 323 BC began the Hellenistic period of ancient Greece. His empire was divided between four of his generals. It was during this period that a new type of king arose based on Macedonian and near Eastern tradition. The first kings in this period had previously been Alexander's generals. They took power following his death. They were able to take power despite not being part of any existing royal lineage and having no historic claim to the lands they controlled. The most significant of these rulers were Antigonus I and his son Demetrius in Macedonia and Greece, Ptolemy in Egypt., and Seleucus I in Anatolia.

The borders of Hellenistic kingdoms were unsettled early in the period. Antigonus, I attempted to expand his land area by attacking the other successor kingdoms of Alexander. These other kingdoms eventually allied against Antigonus. He was killed in 301 BC at the Battle of Ipsus. Demetrius (son of Antigonus I) spent years in Seleucid captivity. The Macedonian throne was reclaimed in 276 BC by Antigonus II (son of Demetrius). The Seleucid kingdom lost large portions of Persia to the Parthian Empire.

During the Hellenistic period the main centers of culture were Alexandria and Antioch.

Alexander's conquests led to many Greeks migrating to the new cities that were founded in the conquered lands. For example, Alexandria in modern day Egypt. Alexandria became a Centre of learning, where thinkers such as Aristotle, Plato, Archimedes, Heron, and Eratosthenes made it an academic center. Some of these cities were as far away as modern-day Afghanistan and Pakistan.

The city-states within Greece divided themselves into two leagues. The Achaean League included Thebes, Corinth, and Argos. The Aetolian League included Sparta and Athens. These leagues were at war much of the time, until Rome conquered Greece.

The Antogonid Kingdom became involved in the First Macedonian War (214 BC to 205 BC) with the Roman Republic in the late third century BC. Rome faced Philip V of Macedon. The war was inconclusive, but Rome kept fighting until Macedon was absorbed into the Roman Republic a few years after the Third Macedonian War. This occurred by 149 BC and the region was designated a Protectorate of Rome. This was the beginning of Rome conquering the Greek world.

The Ptolemaic Kingdom continued in Egypt until it was conquered by the Romans in 39 BC. The Achaean League was absorbed by the Roman Empire in 146 BC.

Roman Greece (146 BC – 324 AD)

Greece was conquered by the Roman Empire under the consul Mummius Achaicus in 146 BC after the Battle of Corinth. Macedonia became a province of Rome. Southern Greece was supervised by a Roman official. There were some Greek poleis that maintained some independence and avoided direct taxation from Rome. Other territories came into the hands of Rome in 133 BC. The Roman general Sulla sacked Athens in 86 BC. Pompey was defeated by Julius Caesar at the Battle of Pharsalus (northern Greece) in 48 BC. In 43 BC, a triumvirate (Second Triumvirate) was formed by Antony, Octavian, and Lepidus. Its purpose was to defeat the Republicans led by Brutus and Cassius. They were defeated in 42 BC at Philippi in eastern Macedon. In 31 BC, the country was annexed by Octavian Caesar as a province of Rome following the defeat of Mark Antony and Cleopatra at the Battle of Actium.

Life in Ancient Greece

The City-State

During the Greek Dark Ages, the people of Greece lived in small farming villages. These villages evolved and developed their own governments. They developed a constitution or set of laws, collected taxes, and raised armies. These city-states were known as poleis, and each was said to be protected by a god or goddess. The citizens of the polis owed the god or goddess respect, reverence, and sacrifice.

Every Greek city-state was different although, they had similar customs and rituals. They varied in size. Sparta was the largest.

As the Archaic period began in the seventh century BC, the city-states had developed common characteristics. Each had an economy based on agriculture, so land was the most valuable resource for a city-state. They were ruled by a few wealthy aristocrats. These aristocrats had a monopoly on political power as well as the best land. Some of these aristocrats claimed to be

descendants of Greek gods. The poor were enslaved to the rich, so for a long time there was conflict between the nobles (aristocrats) and the people.

Colonization

Population growth pushed many men to emigrate from their home poleis to the sparsely populated areas around Greece. This was because land was the most important resource in the city-state.

Greek colonies appeared between 750 BC and 600 BC. These colonies appeared in the Mediterranean, Asia Minor, North Africa, to the Black Sea. There were 1,500 colonial poleis by the end of the seventh century BC. Each of these was an independent city-state. Greek settlement grew approximately tenfold from around 800 BC to 400 BC. The numbers during this time went from 800,000 to 7.5 to 10 million.

There were two ways that Greeks made settlements outside Greece. The first was permanent settlements founded by Greeks that formed an independent polis. The second was the establishment of trading posts, occupied by Greeks as well as non-Greeks. These trading posts were known as emporia and manufactured and sold goods. An example of an emporia would be Al Mina.

The first Greek colony was established when Greeks from the island of Euboea established one at Pithekousai. This was on the island of Ishia in the Bay of Naples.

In 743 BC, the Corinthians established a colony at Syracusae in Sicily. The colony increased in power so rapidly that within a century it had established three subcolonies. Syracuse eventually rivaled Athens.

From 750 BC, Greeks began expanding in all directions. This expansion lasted for 250 years. They established long distance trading networks and boosted the economy of ancient Greece.

Tyrants

Populations grew over time. These agricultural city-states started producing goods like pottery, cloth, metalwork, and wine. Trade in these goods made some people very wealthy and the people put new leaders in charge with the help of soldiers. These new leaders were known as tyrants. Some of these tyrants were as bad as the oligarchs that they replaced. Others proved to be leaders.

Social Structure of Ancient Greece

In Ancient Greece, only free, native-born and landowning men could be a citizen of a city-state. Being a citizen entitled a man to the full protection of the law. In most city-states, social status did not allow for any special rights or power in government. In the city-state of Athens, the population was placed into four classes. Their class depended on how much money they made.

Slaves

Slaves did not have any power, political rights, or social status. Slaves did have the right to own property and have a family. This was subject to the master's permission. Most families, even poor families, owned slaves as household servants or laborers. Slave-owners were not allowed to beat or kill a slave. Slave-owners often promised possible future freedom to encourage their slaves to work hard. Freed slaves did not become citizens. They were known as metics, which is a sort of permanent resident. Metics included foreigners or citizens of other city states officially allowed to live in the city-state.

City-states themselves also owned slaves. These were public slaves and had more independence than family-owned slaves. They often lived on their own and performed specialized tasks. For example, in Athens they were trained to look for counterfeit coinage. Temple slaves acted as servants of the temple's god. Scythian slaves were used in Athens to corral citizens for political functions.

The city-state of Sparta had a special type of slave, known as a helot. They were Messenians taken as slaves during the Messenian War. They were assigned to families and raised food and did household chores for the family. This freed the women for raising children and freed men for devoting time for military training. Helot's masters often treated them harshly, and they revolted at times. The helot system came to an end in Sparta around 369 BC.

Marriage

Marriage in ancient Greece varied with the city-state but was not as much a personal relationship as it is today. Most available historical records on the subject discuss Athens or Sparta and the upper classes. The focus of all marriages was intended to be reproduction, so they considered it a matter of public interest. Marriages were usually arranged by the parents of the bride and groom. Each city-state had its own laws as to marriage. The woman's father gave permission to the man who wanted to marry her. A man's daughters were usually married to uncles or cousins.

The significance of Winter to the goddess of marriage, Hera, made it a popular time to get married. They were typically married primary during the month of Gamelion (equivalent to January). The couple living together is what made the marriage legal.

The man usually chose his wife based on the dowry, her presumed fertility, and her skills. Many girls were married by age 14 to 16 and men married around age 30.

Food and Meals

Food in ancient Greece was generally low cost consisting of cereals, olives, and grapes. Legumes were also very important in the average Greek diet. Cereals from grains, such as wheat and barley were staple foods. Vegetables were often eaten as soups, boiled, or smashed and were often seasoned with olive oil. Olives themselves were a common appetizer. Fresh vegetables were expensive in the cities, so vegetables were often dried. Fruits (i.e. dates, raisins, or figs) and nuts were often served as desserts. Meat and fish consumption varied based on wealth and location. Meat, except for pork, was expensive in the city.

There are three meals mentioned in the Homeric epics Iliad and Odyssey. These meals are ariston (early meal), dorpon (late meal), and deipnon (either). In the later ages the meals were acratisma (early meal), ariston (middle meal), and deipnon (late meal). The late meal was the most important meal of the day and was around nightfall.

Men and women had their meals separately, with the men going first. It was either slaves or wives and children to serve the meals. Terracotta bowls were commonly used.

Education

Education in Ancient Greece was private in most cases. The exception was the city-state of Sparta. Some other city-states established public schools during the Hellenistic period. Education was a commodity as only wealthy families could afford a teacher for private education.

Boys started school at the age of seven. In the city-state of Sparta, they went to the barracks at that age. There were three types of teaching: grammatistes for arithmetic, kitharistes for music and dancing, and Paedotribae for sports. Boys learned to read and write, as well as quote literature. They were trained as athletes for military service. They also learned to sing and play a musical instrument. Education for boys was not for employment, but to become an effective citizen.

The boys of wealthy families that took private school lessons were cared for by a paidagogos. This was a household slave that was selected for this, that followed the boy during the day. The classes were held in the teacher's house. The subjects included reading, writing, math, singing and playing the flute and lyre. At the age of twelve, sports was added to the curriculum. In Athens, older youths attended an academy for the finer disciplines. These included sciences, culture, music, and the arts. Schooling ended at the age of eighteen and then military training occurred in the army for one to two years.

Only a few boys had an education in their past childhood. Some were paired with a mentor. Only the richest continued their formal education, where they studied with famous teachers. Some of Athens' best schools included the Lyceum founded by Aristotle of Stageira in 335 BC.There was also the Platonic Academy at Athens, that was founded by Plato of Athens (380s BC). The education system of wealthy ancient Greeks is known as Paideia.

Girls learned to read and write. They also learned simple arithmetic for managing the household. Girls rarely receive any education after childhood.

Politics, Law, and Government

Ancient Greece was composed of several hundred city-states. The city-state was the basic political unit. This was unique compared to most other societies at the time. Most other societies were tribal or kingdoms and ruled over relatively large territories. The geography of Greece consisted of mountains, hills, and rivers, which was a contributing factor in the fragmented nature of the political scape. Unification was rarely considered by the ancient Greeks. For example, during the second Persian invasion of Greece, a group of city-states created an alliance to defend Greece. The majority of the city-states remained neutral. After the defeat of the Persians, the city-states returned to fighting among themselves.

The fragmented nature of the Greek political system was more geographical than tribal. There were also colonies established throughout the Mediterranean region. When a city-state set up a city-state, it was usually independent of the "mother" or founding city-state.

There were cases where a smaller city-state was dominated by a larger neighbor. This was not necessarily from being conquered. They often grouped themselves into leagues, which was a form of alliance. It was later in the Classical Period that leagues became larger and fewer. They were then often dominated by one city-state, like Athens or Sparta. They were often coerced to join under threat of war, or it would be made as part of a peace treaty. A good example of this was after Philip II of Macedon conquered many areas of ancient Greece in 338 BC. He didn't attempt to annex the areas but forced the city-states to join the Corinthian League.

Initially the city-states often resembled a small kingdom. There was also an official of the city-state that carried out ceremonial functions of the king. This had changed by the Archaic Period and most of these city-states had become aristocratic oligarchies.

The wealth and political power were concentrated in small groups of families. In many city-states a tyrant would seize control. The city-state of Athens came under a tyrant in the second half of the sixth century BC. A new solution was developed to prevent the aristocracy from regaining power, democracy. There was a citizens' assembly for the discussion of city policy that came out of the reforms of Draco in 621 BC. After the reforms of Solon in the early sixth century all citizens could attend. Solon's reforms laid the foundation for democracy in Athens. The poorest citizens, however, could not run for office or address the assembly. When the assembly became the established mechanism of government, all citizens were equal in the assembly. Non-citizens, slaves, and metics had no political rights at all.

In 508-507 BC, the Athenian statesman Cleisthenes furthered the efforts of Solon and established a constitution in Athens. The constitution was based on democratic ideals. Cleisthenes is regarded as the "father of Athenian democracy".

There were two features of ancient Greek democracy. The first was sortition, which was the random selection of citizens to serve administrative duties and hold judicial offices. The second feature was the legislative assembly, where all Athenian citizens could vote.

Other city-states founded democracies after the rise of democracy in Athens. Sparta, was ruled by two hereditary monarchs. Their power was kept in check by a council of elders and appointed magistrates.

Athens passed legislation and developed a framework of laws for water management. They also created institutions that would enforce these laws. The first regulations to be passed were developed by the Athenian statesman and poet, Solon. In the early sixth century he reformed Athens. One of the issues was around the city's public water supplies grew, the private cisterns and wells began to be abandoned. The regulations forced these private owners to maintain these wells in good condition and ready for use, as they could be needed in the event of war. There were other laws passed to protect the surface waters from pollution. For example, in 440 BC there was a law for tanners, to prevent them from disposing of their waste in the Ilissos river.

Athens had a system for selecting juries so that those accused of crimes were judged by their peers, similar to what we have today. They selected members of a jury from the assembly at random using a machine called the kleroterion. The kleroterion randomly dispensed tokens, and if a member of the assembly drew a black one, they were required to perform jury service that day.

Economy

Classical Greece was one of the most prosperous societies of the ancient world at its economic best in the fifth and fourth centuries BC. Wages quantified in terms of wheat gave higher wages for urban dwellers than for farm workers. An unskilled urban worker in Athens made approximately 7-12 kg of wheat compared to 3.75 kg for an unskilled rural (farm) worker in Roman Egypt. Farm incomes were on average lower than urban workers, much like today.

Philosophy

Philosophy in ancient Greece had a focus on reason and inquiry. It influenced modern philosophy as well as modern science. The first known philosophers of ancient Greece were known as the pre-Socratics. They attempted to provide realistic and non-mythical descriptions of the world. They were followed by Socrates from Athens. His ideas are the basis of Western philosophy. His ideas are known mostly from second-hand accounts, not from his own writings. One of his followers was Plato, who wrote The Republic, as well as establishing a difference between ideas and the concrete world. One of Socrates' other followers was Aristotle. He wrote about nature and ethics. He was also quite influential in Western philosophy.

Socrates devoted himself to inquiry into righteous conduct by cross-questioning. He was brought up on a charge of corrupting youth in 399 BC, that was initiated by the poet Meletus. He was sentenced to death and died after drinking poison hemlock.

The Socratic period of philosophy has influenced scientific, political, and metaphysical thought up to modern times.

Religion

Religion was an important part of life in ancient Greece. Because ancient Greece was divided into city-states, there was not a uniform religion or God. The different cities and tribes did worship similar gods, and they were thought of differently from one city-state to another. The practices of their neighbors often influenced their own. The ancient Greeks were polytheistic, which means that they worshipped many gods. Around the sixth century BC a core of twelve Olympians began to take shape. Mount Olympus was believed to be the home of the gods.

Animal sacrifice, such as sheep and goats, was one of the most important practices of the ancientGreeks. The ritual sacrifice had public prayer along with it. Hymns and prayers were also a major part of ancient Greek religious practices.

Literature and Theatre

The Greeks had an appreciation for poetry, theatre, and music. Most Greek cities had a theatre, some of which could hold 15,000 people. The Athenians invented theatre performance in the sixth century BC. Engineers often created entertainment technology. The main purpose was to amaze the audience. Small automatic theatres were created by Greek engineers. These had pre-programmed production.

The architecture of theatres was modified to add stage machinery. This machinery added special effects, like the descent of characters, instant scenery changes, movable carts, and turning stages.

Early Greek literature was poetry, and it was composed for public performance. Migrations during the Archaic period influenced art and literature. Greek style and literature were spread by the migrations. One of these writers of the period was the blind bard Homer, from Ionia, who is known for the “Iliad” and the “Odyssey”, produced around 750 BC, during the Archaic Period. Homer composed poetry orally. Sculptors during the period created the kouroi (male) and korai (female) figures that served as memorials to the dead. Archilochus was the first to compose poetry in writing around the mid-seventh century BC.

The earliest lyric poets in ancient Greece were active around 650 BC. One of the great innovators in meter and language was Archilochos of Paros, who was an iambic and elegiac poet. Tyrtaeus of Sparta, an elegiac poet, urged the Spartans to fight in the Second Messenian War.

Sappho was a poet on Lesbos around 610 BC. Her poems were described as personal, and reflected her reverence for Aphrodite and the Muses, as well as her affection for her friends.

The ancient Athenians invented theatre performance in the sixth century BC.

The tragedy developed towards the end of the Archaic Period. It took elements of the pre-existing genres of poetry. Comedy began to develop in the beginning of the Classical Period. The first preserved Ancient Comedy was Aristophanes' Acharnians, which was produced in 425 BC. Comedy competition became an official event in 486 BC in Athens at the City Dionysia.

Greek prose also had its beginning in the Archaic Period but did not mature until the Classical Period. Prose first emerged as a writing style, adopted by the presocratic philosophers Anaximander and Anaximenes (sixth century BC) through Thales of Miletus (one of the first Greek philosophers). The major Greek prose genres of history, philosophy, rhetoric and dialog developed during this time period.

The Greek world's center of literature moved from Athens to Alexandria during the Hellenistic period. There was also a shift in the way that Greek literature was consumed. It shifted from public performance to being read privately and the poets began to write for private reading. It was due to the patronage of the Hellenistic kings, as well as the museum at Alexandria, that so much ancient Greek literature has survived. The Library of Alexandria was part of the museum.

Rome became a major player in Greek literature after the victory of Octavian at Actium in 31 BC. Important Greek authors went to Rome. It was during the second century AD that the Greatest innovation in Greek literature under Rome occurred. The time from around 80 AD to 230 AD marked the development of the novel.

Another form of the arts that was popular in ancient Greek society was music. Music was an important part of public religious ceremonies, as well as private weddings and funerals. The music was primarily vocal that was usually accompanied by an instrument. It was less common to have instrumental music without vocals. The Greeks used instruments such as harps, lutes, lyres, zithers, aulos, and the Ctesibius' organ. Percussion instruments only support the wind and string instruments.

The Library of Alexandria

The Library of Alexandria was in Alexandria, Egypt. It was of the largest libraries in the ancient world and doubled as a research institution. It was part of a larger institution known as the Mouseion. The idea of the library was said to be proposed by Demetrius of Phalerum, who was an exiled Athenian statesman and student of Aristotle. He was living in Alexandria and was said to have proposed the idea to Ptolemy I Soter. The Library was not built until Ptolemy II Philadelphus, son of Ptolemy I Soter. By that point Demetrius of Phalerum had fallen out of favor, so it is disputed that he had a role in the founding of the Library. The Library had an aggressive campaign for acquiring texts, which were on papyrus scrolls.

Many important scholars came to work at the Library in the third and second centuries BC. Among these were Zenodotus of Ephesus, whose work was standardizing the works of Homer. Zenodotus of Ephesus was also the first recorded head librarian. Callimachus, wrote the Pinakes, that is considered the first library catalog. Eratosthenes of Cyrene calculated the circumference of the Earth to an accuracy of a few kilometers. He is also the first to use the

word geography and created his own world map. Heron of Alexandria also worked at the Library. He invented the first steam engine.

The Library declined, starting with a purge of intellectuals from Alexandria in 145 BC. The Library, or part of the collection was accidently burned by Julius Caesar in 48 BC, during the civil war. The Library declined during the rule of Rome. The main reason was lack of funding and support.

Architecture and Art

Ancient Greek architecture and art still has an influence today on our own architecture. This is especially in the areas of architecture and sculptures. Many aspects of the art of the Roman Empire were built on the Greek models. The eastern conquests of Alexander the Great were influenced by Greek art.

The theatre at Syracuse was built in mid-sixth century BC. It was later enlarged under Hieron II. It is one of the largest Greek theatres known in the ancient world.

One of the great architectural achievements of Ancient Greece was the Parthenon, built in the fifth century BC. It is also one of the most famous of the architectural achievements in ancient Greece. It was originally a temple on the Athenian Acropolis that was dedicated to Athena (Greek goddess). It replaced an older temple dedicated to Athena that was destroyed in the Persian invasion of 480 BC. It was designed and built by the Greek architects Iktinos and Kallikrates, between 449 BC and 432 BC. It incorporated the Doric and Ionic orders of classical architecture and was primarily made from Pentelic marble. It was built after the Hellenic victory over invaders from the Persian Empire. It also served as the treasury for the city of Athens and for a time, the treasury for the Delian League.

The Temple of Olympian Zeus in Athens is another example of Greek architecture. The temple was built, starting in the sixth century BC. It was designed to be the largest temple in Greece and was built over several centuries. It was built using the Corinthian order of columns.

Around 525 BC, the red-figure pottery technique was developed in Athens. This style has red figures on a black background. This is the exact opposite of black-figure pottery with blackfigures on a red background (color of the clay).

Engineering and Scientific Accomplishments

The Ancient Greeks had many engineering and scientific accomplishments that still survive today. The Romans took many Greek ideas and adapted for their own use. There was a lot of Greek influence in Ancient Rome. Many of their ideas were inspired by the need for improved weapons and tactics for war. For the most part, scientific research was rarely intended for practical applications in ancient Greece.

Ancient Greek mathematics led to the mathematical concepts that we know today. The basic rules of geometry and formal mathematical proof were among those ideas. There were

discoveries by several Greek mathematicians, including Pythagoras, Euclid, Thales, and Archimedes that we still use today. They first codified geometry in set of axioms, where Egyptians and Babylonians had used it for practical necessity. Pythagoras and Thales had traveled to Egypt and Babylon to learn and adapt methods from other ancient civilizations.

Thales has been credited with the derivation of five theorems of geometry. He was the first man to be credited with specific mathematical discoveries. It has been reported that he measured the heights of the pyramids by using similar triangles.

Pythagoras of Samos has been described as the first pure mathematician and known as the "Father of Numbers". He was a student of Anaximander. He went to Egypt soon after the tyrant Polycrates came to power in Samos. He is credited with several theorems in mathematics, including the discovery of irrational numbers. He is best known for the Pythagorean Theorem.

Harpalus built the pontoon bridge that was used by Xerxes to cross the Hellespont in 480 BC.

Dinocrates of Rhodes was a Greek architect and engineer in the fourth century BC. He went with Alexander the Great on his campaigns. His most known accomplishment was his plan for the city of Alexandria. He also designed the funeral pyre of Hephaestion and the reconstruction of the Temple of Artemis.

Sostratus of Cnidus was an architect and engineer that designed the Great Lighthouse at Alexandria. It was built in the third century BC. He was the architect of the Tetra Stadium in Alexandria, Dexiphanes. He also designed the Suspended Pleasure Gardens in Cnidus which were very similar to The Hanging Gardens of Babylon. He also built diversionary canals in the Nile River at Memphis. He also built the Clubhouse of the Cnidians at the Santuary of Apollo in Delphi.

Polyidus of Thessaly was a Greek military engineer. He worked for Alexander the Great's father, Philip II. He is well known for improving covered battering rams during the 340 BC siege of Byzantium. A couple of his students served under Alexander the Great. He is known for inventing the Helepolis, which was a large siege tower.

Philo of Byzantium was a famous Greek engineer that lived in the third century BC. He spent most of his life in Alexandria. He wrote on topics in mathematics, mechanical toys and diversions. He also wrote about military and naval topics such as weapons and harbor building. He wrote detailed descriptions of water mills, repeating crossbows and a gimbal.

Euclid of Alexandria was considered the "Father of Geometry". He wrote *Elements*, which is considered one of the most influential books in history. *Elements* was a systematic discussion of geometry. Euclid's writings remain the partial basis of mathematics, even today.

Archimedes was one of the most important thinkers and inventors of the ancient Greek world. Archimedes Principle is an important concept in hydrostatics. He discovered water displacement in his bath and cried "Eureka!" He wrote about the lever in the third century BC. He designed defensive weapons used against a Roman siege of Syracuse in 214 BC. These defensive mechanisms included catapults, a "death ray" mirror system, and the "Archimedes Claw" that

was used to capsize ships. He was killed by a Roman soldier when the city's defenses were breached. Sources state that he was consumed by calculations at the time he was killed. His last words were supposedly "Do not disturb my circles".

Heron of Alexandria was a famous engineer in antiquity, living in the first century BC. He made developments in mathematics, physics, and engineering and established the Higher Technical School of Alexandria. He developed the first steam engine and odometer. He also developed the first robotic automation and the first vending machine that was used to dispense holy water.

Scientists and mathematicians made significant progress during the Archaic period. One of these scientists, Anaximandros, developed a theory of gravity. Xenophanes discussed his discovery of fossils. Pythagoras of Kroton developed the Pythagorean Theorem.

Astronomy

The ancient Greeks thought of astronomy as a branch of mathematics and developed it to a sophisticated level. They wanted to know how the universe worked. It was the Greeks that discovered the Earth was round. They had also calculated the Earth's diameter and calculated the distance from Earth to the Moon. Eudoxus of Cnidus and Callippus of Cyzicus developed the first three-dimensional models in the fourth century BC to explain the apparent motion of the planets. Heraclides Ponticus proposed around the same time, that the Earth rotates around its axis. In the third century BC the heliocentric system, where the Earth and planets rotate around the Sun, was first suggested by Aristarchus of Samos, later known as the "Copernicus of Antiquity". This hypothesis was revived by Archimedes in his composition The Sand Reckoner. Achimedes had measured the apparent angle of the Moon. He made observed that during a lunar eclipse, the Moon remains in the shade of the Earth and moving 2.5 times its diameter. By his logic, if the shade of the Earth was cylindrical, the diameter was 2.5 times that of the Moon. Eratosthenes calculated the circumference of the Earth using angles of shadows cast from objects at two different latitudes. He had an error of less than two percent.

Meton of Athens studied engineering and geometry and was later cited by the Roman engineer Vitruvius. His most noteworthy accomplishment was his discovery of the 19-year "Metonic Cycle" that became a large part of Athenian calendars. His work in astronomy led him to construct a solar calendar around 433 BC. He also built the Colonos aqueduct in Athens.

Hipparchus of Nicaea made contributions to astronomy in the second century BC. One contribution was the first measurement of precession, the change in the orientation of the axis of rotation of rotating body. He also compiled the first star catalog. In this compilation, he proposed the modern system of apparent magnitudes. Hipparchus became known as the "Father of Trigonometry" for compiling the first trigonometric table. He is also possibly the one who divided the circle into 360 degrees, based on his work on the table of chords.

Hipparchus knew the Earth was spherical. He measured the latitude of any location using a quadrant and a plumb line.

Hipparchus made the discovery that the Sun is much larger than Earth. He determined that the shade area was conical. He calculated that the moon was four times smaller than the Earth. His calculation was close to true value. He could calculate how far the Moon was from Earth from the Moon's apparent angle and its diameter.

Hipparchus invented the astrolabe. The astrolabe was a tool (analog computer) that was used to measure geographical latitude and time, by observing stars at any point of the Earth. It was also used to measure the distance from the moon from the sun and measure the position of the moon during the day.

Medicine

The ancient Greeks made significant strides in medicine. The early Greeks considered illness to be a divine punishment. Beginning in the fifth century BC a more scientific approach was taken, beginning with Hippocrates.

One of the most famous physicians of the Classical period was Hippocrates (born in 460 BC). He is considered the "father of modern medicine" and founded the Hippocratic school of medicine. This school of thought established medicine as a distinct discipline separate from other fields.

Hippocrates was the first to reject the thought that illnesses were punishments that were inflicted by the gods or were the result of other superstitious ideas. Hippocrates' school of thought was the basis of Western medicine, and the Hippocratic oath provided a professional guide for all physicians. He pioneered observation, clinical trials, and documentation.

Water Technology

Water resources were important for the ancient Greeks, since Greece did not have large rivers. Water scarcity was an issue in ancient Greece. They developed water resources for mostly urban use. They constructed aqueducts to bring in the water supply. They also developed sewage systems for wastewater and storm water. The developed systems for protection against floods. They built fountains and baths.

The ancient Minoan civilization was the first to use water technology in ancient Greece. They used underground clay pipes for their water supply and for sanitation. There was an efficient water system in Knossos. It brought in fresh water, removed sewage, and had storm sewer channels for drainage in heavy rain. The ancient Greek city-state of Athens had an indoor plumbing system for pressurized showers. Heron applied the system of pressurized pipes to make a fire extinguisher to put out fires in the city of Alexandria in Egypt.

Ancient Greece was also one of the first to build aqueducts for the supply of fresh water to the city as well as to irrigate crops. Many of the aqueducts were run underground at a depth of 60 feet. They also had special protection to prevent rupturing. Athens depended on the aqueducts or deep wells for their water supply. The sewage often flowed into rivers and streams, so public

fountains supplied fresh water for the residents that was piped in from outside the city. Sometimes wastewater was used for irrigating crops. The gray water (from showers and baths, etc.) was given to the animals, or used to water house plants. Rainwater was used as a source of water to irrigate crops.

Culverts were constructed using cement-lined stone blocks. They were large enough for a person to maintain using inspection shafts. There were many of the ceramic clay pipes that were used for small sections of the aqueducts and sewers. Storm drains were sometimes made of carved stone like a gutter would be today.

It was a Greek engineer that found a solution to balance construction needs with the physical properties of water flow.

An example of the water technology includes the drainage system in the Anatolian west coast (Turkey). In included a masonry outlet structure that allowed for self-cleaning of the outlet.

Athens was the most important city in ancient Greece. During the fifth century BC, Athens had a population of over 200,000. To establish a water supply for Athens had to utilize three natural springs as well as constructing cisterns to store stormwater. Also, for crop irrigation there were two streams, Kephisos and Ilissos.

The first major hydraulic project in Athens was the Peisistratean aqueduct built under the Tyrant Peisistratos, as well as his sons. He was in power from 546 BC to 527 BC. It was carved mostly as a tunnel reaching a depth of 14 meters. There was a ceramic pipeline at the bottom. The Greeks built this way for security reasons. Their hydraulic projects were mostly underground, so they were not exposed to potential enemies.

Making laws creates an institution to enforce them. A public administrator position was created to operate and maintain the city's water system. This administrator also monitored the enforcement of the water regulations as well as insure water was distributed fairly.

One ancient Greek hydraulic project was the Alyzia dam. The dam was likely built in the Classical Period, around the fourth century BC. The purpose of the dam was to protect the downstream plain. It had a stone carved spillway and operated even today, although the spillway has experienced erosion over the years.

Mining

The ancient Greeks developed mines and mining technology. They had large silver mines at Laurium (near the Mediterranean and south of Athens). The washing table still exists at this site. The profits from the silver mine helped Athens grow. The site supported several processes, beginning with mining in underground galleries. Washing, then smelting to produce the silver. Mining helps to create coinage that was used as currency. Greek mines were worked by slaves. They had tunnels that went to a depth of 330 feet and the slaves used picks and iron hammer to work the mine. The mined silver ore was taken out of the mine by a small skip attached to a rope that was guided by a wheel at the rim of the shaft.

Archimedes Screw

The Archimedes' screw was a device that was capable of lifting liquid (i.e. water) or solid (i.e. grain) substances from a lower elevation to a higher one. This invention was attributed to the Greek mathematician Archimedes of Syracuse in the third century BC, and it is said that he invented it while studying at the Library of Alexandria. It was a sort of pump.

Streets

Streets first appeared in approximately 400 BC. An example is the Porta Rosa, built during the fourth to third centuries BC, during the Hellenistic Age. It was the main street in Elea in modern day Italy. It connected northern to southern quarters and was five meters wide. It had an incline that was as steep as 18 percent. The paving was limestone blocks, girders cut into square blocks, and a small gutter on one side for drainage.

Cartography

During the sixth century BC, there was a combining of geographical maps by Anaximander of Miletus (philosopher). He was the first to map the known world and is considered the first mapmaker. Eratosthenes was the first to put forth a spherical Earth.

Rutway

This was a rudimentary form of a railway in approximately 600 BC. It was between 6 and 8.5 kilometers and was a stone road used to haul cargo and ships over land. It forced a cart to follow a certain path, much like a railway does.

Differential Gears

From 100 BC to 70 BC, there was the Antikythera mechanism, which is an analog (mechanical) computer. It was found in the Roman-Era Antikythera shipwreck in 1901. It was found off the Greek island of Antikythera, which is located between the islands of Kythera and Crete. It used a differential gear in determining the angle between the ecliptic positions of the sun and moon, which allowed determination of the phase of the moon. These gears had previously been thought of as being invented in the eighteenth century. It is also said to be able to calculate the movement of the planets.

Calipers

Dates back to the sixth century BC. An example of calipers was found in the Giglio wreck, near the coast of Italy. It was a wooden piece that had a fixed and a movable jaw.

Crane

The crane was developed around 515 BC and was based on the Mesopotamian shadout that was used for irrigation. It was a labor-saving device that allowed small work teams on construction sites to efficiently lift a load (usually heavy stone blocks). The winches were later devised for heavy weights.

The ancient overhead crane was mounted on a mobile platform. A winch was used to allow it to tilt forward or backward, and to lift the load.

Winch

The winch was developed in the fifth century BC. The earliest reference is found in the account of Herodotus of Halicarnassus (father of history) about the Persian Wars. He described how wooden winches were used to tighten cables on a pontoon bridge across Hellespont strait in 480 BC. They may have been used in Assyria. They were used common in architectural use commonly by the fourth century BC, according to Aristotle.

Archimedes designed a winch that used a gearbox. He was able to move heavy loads with one hand.

Escapement

These were first described by Philo of Byzantium in the third century BC. It was a part of a washstand automation for guests washing their hands. He indicated that these escape mechanisms were already integrated into ancient water clocks.

Tumbler Lock

Various forms of locks, including the tumbler lock, were developed in Greece during the fifth century BC.

Plumbing

Developed in the fifth century BC. The ancient Minoans used underground clay pipes for sanitation and water supply. Extensive plumbing systems were revealed during excavations of Olympus and Athens. These plumbing systems were used for baths, fountains, and personal use.

Urban Planning

The "father" of urban planning was Hippodamus of Miletos. Urban planning began in the fifth century BC. One of the first known towns with a grid–like plan was Miletus. Hippodamus originated the idea of a town plan based on a rational social order. This plan included public and residential areas. Innovations in surveying helped in this area.

Hippodamus made a plan of an ideal city (according to Aristotle). The ideal city was to be inhabited by 10,000 men and the overall population that included women, children, and slaves reached 50,000.

Showers

This dates back to the fourth century BC. An Athenian vase depicts a shower room for female athletes. There was also a second century BC gymnasium at Pergamum, which is in modern day Turkey.

Central Heating

In approximately 350 BC, central heating was used in the Great Temple of Ephesus. Heated air was circulated through flues that were built into the floor.

Lead Sheathing

Developed in approximately 350 BC. Lead sheathing was used to protect a ship's hull from boring creatures.

Ancient Suez Canal

There was an ancient canal opened in the early third century BC. It was designed by Greek engineers under Ptolemy II. There was a canal lock built into the canal.

Lighthouse

These are traced back to the third century BC. Palamidis of Nafplio invented the lighthouse, according to Homeric legend. There were earlier examples in the fifth century BC, but not as sophisticated.

Tunnel of Samos

Water tunnel (underground aqueduct) excavated through mount Kastro on the Greek island of Samos. Construction began in 530 BC (some references 550 BC) and took 10 years to complete. This was in the sixth century BC during the reign of the tyrant Polycrates. They determined the direction for digging straight line from both ends. This as without the aid of a magnetic compass, surveying instruments, or topographic maps. He carved segments of the straight line from two points.

Polycrates employed the Greek engineer/surveyor, Eupalinos of Megara to design the system. The water was brought from its source at Agiades. It was brought to the north of the tunnel by underground conduit. It followed an 850-meter curved course and passed under three creek beds. Once the water entered the tunnel flowed through a sloping rectangular channel. It left the tunnel a few meters from the south entrance, heading west in a conductive way leading to the city. This required a good working knowledge of geometry and was a total of 1036 meters long.

Eupalinos also found an engineering solution to the principle that water must have a gradient to flow. He excavated a sloping channel on one side of the floor in the horizontal tunnel. A small tunnel below the main tunnel was built where the depth of the channel would be high.

Water Clock

The water clock was introduced to ancient Greece around 325 BC. The water clock, also known as a clepsydra, worked by measuring fluid flow that leaked from a container at a constant rate. The main methods of telling time were the water clock and the sundial. The water clock did not rely on the sun, thus could be used at night. The water clock dates as far back as the fourteenth century BC in Babylon, Egypt, and Persia.

Alarm Clock

The alarm clock dates back to the third century BC. Ctesibius (Hellenistic engineer) fitted his water clock with a dial and pointer to indicate the time. He configured it to where it could drop pebbles on a gong or blow trumpets at a specific time. This was accomplished by forcing bell-jars into water and taking the compressed air through a beating reed. It is stated that Plato and Aristotle had alarm clocks. The alarm clock of Plato was a little more complicated than Aristotle's. Plato's imitated the chirping of a bird to wake him up. Plato's relied on the siphoning of water into a separate vessel similar to a kettle. It made a loud whistle from thin holes when the vessel was full.

Odometer

The first odometer dates back to the third century BC. Like today, it was used to measure distance travel. There is disagreement on where the idea came from. Some historians attribute it to the Heron of Alexandria and others to Archimedes. The odometer helped in the building of roads as well as traveling them by accurately measuring distance.

The odometer in ancient Greece was based on a reduction gearbox. It was mounted on a cart and it counted the number of revolutions of the wheels.

Chain Drive

The chain drive was first described by Philo of Byzantium in the third century BC. It powered a polybolos (repeating crossbow).

Cannon

Ctesibius of Alexandria invented a primitive form of cannon in the third century BC. It was operated using compressed air.

Double-Action Principle

The double action principle was first realized in the third century BC by Ctesibius. He developed a double-action piston pump. This was later developed further by Heron in his fire hose.

Fire Hose

The fire hose was invented in the first century BC by Heron. It was based on Ctesibius' double-action piston pump to allow efficient firefighting.

Levers

Put to practical use in Ancient Greece. They were used in prehistoric times, but were first described by the Archimedes, the Greek mathematician, around 260 BC.

Water Mill

Developed in approximately 250 BC. Waterpower was first developed by the Greeks. Philo's Pneumatics has the earliest description of a water mill. The ancient Greeks invented both the water wheel and the toothed gearing that turned it. The water mill was used to grind wheat, cut stones, and extract water. The water mill decreased the human workload, thus was vital to productivity.

The ancient Greeks invented the two primary components of a watermill. These components were the water wheel and the toothed gearing. The water wheel was first described by Philo of Byzantium in the third century BC.

Gimbal

The gimbal dates to the third century BC and was invented by Philo of Byzantium. It is an eight-sided ink pot with an opening on each side. It can be turned so that any face is on top, a pen dipped in and the ink does not run through the holes in the side. An inkwell is at the suspended at the center. The inkwell was mounted on a series of concentric metal rings. These metal rings remained stationary regardless of which way the pot turned.

Density Meter

Archimedes invented a density meter. It is based on Archimedes principle. Archimedes observed the level of bathwater to rise as he got in, which gave us his principle of buoyancy. It was a floating device in a liquid of higher density. It measured displacement and is still used today by winemakers to measure alcohol concentration. The density meter was a graduated metal tube that was closed on one end. It was immersed in the liquid to be tested, and the relative density was indicated by its equilibrium position.

Air and Water Pumps

Developed in the second century BC. Various Greeks of Alexandria, including Ctesibius, developed practical uses for air and water pumps. They served a variety of purposes, for example, a water organ. Another example is Heron's fountain, from the first century AD.

Surveying Tools

Greeks adapted many Egyptian surveying techniques, which were eventually inherited by the Romans. The two most noted surveyors/engineers in ancient Greece were Eupalinos of Megara and Hippodamus of Miletos. It has been speculated that the dioptra was used to build the Tunnel of Samos.

One instrument used by the ancient Greeks for an astronomical and surveying instrument was the dioptra. The dioptra dated to the third century BC. By the second century BC, it was replaced as an astronomical tool but was still used in surveying. The dioptra was a sighting tube, or a rod with a sight at both ends. It could be used to measure angles when fitted with a protractor. It was replaced by the theodolite as a surveying instrument.

Analog Computer

The Antikythera mechanism was used around 150 BC. This device was found in the Antikythera wreck in 1900-1901. This device was thought to be an analog computer. It is thought to be designed to calculate astronomical positions and used to predict solar and lunar eclipses. It was based on Babylonian arithmetic progression cycles. It used dozens of gears.

Vending Machine

The first vending machine was designed in the first century BC by Heron of Alexandria. His machine was invented for one of the temples. His machine took a five-drachma coin deposited and then dispensed holy water in a fixed amount. The coin fell on a pan attached to a lever. The level opened a valve to release water. The pan continued to tilt with the weight of the coin, until the coin fell off the pan. A point a counterweight snapped the lever back up, which turned off the valve.

Wind Vane

The wind vane was developed in 50 BC. It was on top of the Tower of the Winds on the Roman agora in Athens. It was in the form of a bronze Triton holding a rod in his hand. His outstretched hand rotated as the wind blew, pointing in the direction the wind was blowing.

Clock Tower

The Tower of the Winds built around 50 BC, as described above, also had sundials and a water clock. It was approximately eight meters tall. It was decorated with eight wind deities.

Steam Turbine

The first steam turbine was developed by Heron of Alexandria around the first century AD. It was known as an "Eolipyle".

Automatic Doors

Automatic doors date back to the first century AD. Heron of Alexandria who was an inventor from Alexandria, Egypt. His schematics were for automatic doors to be used in the temple while sacrifice was performed. They operated with the aid of steam power.

Weapons and Ships

Many technological developments in ancient Greece were military. Dionysios of Alexandria designed the polybolos, which was an automatic repeating catapult. It had the capability of launching heavy arrows to a long-distance target. Archimedes designed the first steam cannon.

The triaconter, that was mentioned in the Iliad, gradually developed into the bireme and the trireme. These had two and three rows of oarsmen on each side of the ship. There were assets that led to the victory in the Battle of Salamis in 479 BC.

Archimedes designed burning mirrors in the third century BC. Writers described them as burning the Roman fleet. Large hexagonal mirrors consisted of smaller mirrors that were adjusted to the main mirror using blades and joints.

Spiritsails were the earliest form of fore-and-aft sail. They date back to the second century BC. They appeared in the Aegean Sea on small Greek watercraft. The three-masted ship appeared around 240 BC. Syracusan merchant ships began to have them under Hiero II of Syracuse.

Conclusion

Ancient Greece stands as a cornerstone in the foundation of Western civilization, influencing nearly every facet of modern society. From governance and philosophy to science, architecture, and engineering, the Greeks pioneered innovations that have existed for millennia. The democratic ideals of Athens introduced the world to participatory government, laying the groundwork for democratic political systems that are still in use today. Philosophers such as Socrates, Plato, and Aristotle expanded the boundaries of human understanding, shaping ethics, metaphysics, and logic in ways that continue to influence modern academic and intellectual pursuits.

In the realm of engineering and science, the Greeks demonstrated remarkable creativity and foresight. The ancient Greeks invented devices like the Antikythera mechanism, an analog computer that predated similar technologies by centuries, and the Archimedes' screw, which remains a vital tool in irrigation. Their water management systems, including aqueducts, underground tunnels, and cisterns, addressed issues of scarcity and urban development, reflecting a profound understanding of hydraulics and environmental adaptation. The Tunnel of Samos, an impressive feat of engineering precision, exemplifies their ingenuity in overcoming geographic and technological challenges.

The Greeks also excelled in art and architecture, leaving behind masterpieces that continue to inspire. Structures such as the Parthenon showcase their ability to mix form and function, embodying both aesthetic beauty and structural innovation. The use of orders like Doric, Ionic, and Corinthian set standards for architectural design, influencing the construction of public buildings worldwide. Similarly, advancements in sculpture, pottery, and theatre reveal their commitment to artistic expression and cultural identity, contributing timeless works to humanity's creative legacy.

Militarily, the Greeks combined strategy and technology to achieve remarkable successes, as seen in the development of advanced weaponry, naval engineering, and defensive innovations like the Helepolis siege tower. The triremes of the Athenian navy, which played a decisive role in the Battle of Salamis, demonstrated how their technological advancements extended to both land and sea.

Greek scientific achievements were equally groundbreaking, ranging from the codification of geometry by Euclid to Archimedes' contributions to mechanics and hydrostatics. Their understanding of astronomy, including the heliocentric hypothesis proposed by Aristarchus, laid

the groundwork for future explorations of the universe. Figures like Hippocrates revolutionized medicine by advocating a scientific approach to diagnosis and treatment, separating it from superstition and setting the stage for modern healthcare.

Perhaps most remarkable is the enduring influence of these achievements over the years. The Romans adopted and refined Greek innovations, ensuring their survival and dissemination across the ancient world. Through Renaissance rediscovery and continuous study, Greek contributions have become the foundation for advancements in technology, government, and the arts.

In essence, Ancient Greece was a beacon of creativity and intellectual pursuit, overcoming the limitations of its time to create a legacy that resonates to this day. Their contributions to politics, science, mathematics, and culture serve as a reminder of humanity's boundless potential. As we continue to draw inspiration from their innovations, we pay homage to the architects of a civilization that forever shaped the course of human history.

Timeline of Major Events in Ancient Greece

Event	Date
End of Mycenaean Civilization	~1100 BC
Greeks begin settlements in southern Italy	800 BC
Olympic Games begin	776 BC
Homer writes the “Iliad” and the “Odyssey	~750 BC
Greeks begin expanding by establishing colonies	~750 BC
The Corinthians establish a colony at Syracusae	743 BC
Draco was appointed to establish a legal code	621 BC
Athenian legislator Solon given authority to enact reforms to balance power between rich and poor	594 BC
Death of tyrant Pisistratus	527 BC
The red-figure pottery technique is developed in Athens	525 BC
The Athenian statesman Cleisthenes establishes a constitution in Athens	508-507 BC
Greek cities of Ionia revolt against the Persian Empire	499 BC
Darius I launches first Persian invasion of Greece	492 BC
Comedy competition becomes an official event in Athens	486 BC
Xerxes launches an invasion	480 BC
Battle of Salamis, there the Persians were defeated at sea	479 BC
The Delian League is founded by Athens	477 BC
War breaks out between the Peloponnesian League and the Delian League	458 BC
End of the Persian Wars	449 BC
Peace treaty signed between Peloponnesian League and Delian League	447 BC

Completion of the Parthenon	432 BC
Beginning of the Peloponnesian War	431 BC
Athens has a plague that kills approximately a quarter of its people	430 BC
Death of Pericles	429 BC
Athens captures 300-400 Spartan soldiers at the Battle of Pylos	425 BC
First preserved Ancient Comedy is produced	425 BC
Peace of Nicias is signed	421 BC
Second stage of the Peloponnesian War Begins	415 BC
Oligarchical revolt in Athens	411 BC
Alcibiades replaced after defeat at the Battle of Notum	407 BC
Athens wins the Battle of Arginusae	406 BC
Battle of Aegospotami	405 BC
End of the Peloponnesian	404 BC
Lysander, installs a pro-Spartan government in Athens known as the Thirty Tyrants	404 BC
The Thirty Tyrants are overthrown	403 BC
Streets first appear	~400 BC
Socrates is brought to trial on a charge of corrupting youth and sentenced to death	399 BC
Corinthian War	395-387 BC
The city-state of Thebes defeats Sparta at the Battle of Leuctra	371 BC
The helot system came to an end	369 BC
Sparta and Athens join forces against Thebes, but are defeated at the Battle of Mantinea	362 BC
Philip II defeats a Greek alliance at the Battle of Chaeronea	338 BC

Philip II is assassinated	336 BC
Alexander the Great, son of Philip II, begins a campaign to invade Persia	334 BC
Alexander the Great defeats Darius III at the Battle of Issus	333 BC
Alexander the Great declares himself King of Asia after the Battle of Gaugamela	331 BC
Alexander the Great leads expeditions into Bactria and India	329 BC
Death of Alexander The Great, the Hellenistic Period Begins	323 BC
Battle of Ipsus	301 BC
Antigonus II reclaims the Macedonian throne	276 BC
The First Macedonian War with the Roman Republic	214-205 BC
Macedon was absorbed into the Roman Republic after the Third Macedonian War	149 BC
Rome conquers Greece	149 BC
The Achean League is absorbed by Rome	146 BC
Purging of intellectuals from Alexandria	145 BC
Roman general Sulla sacks Athens	86 BC
The Battle of Pharsalus in northern Greece where Pompey is defeated by Julius Caesar	48 BC
Library of Alexandria accidently burned by Julius Caesar	48 BC
Triumvirate is formed by Antony, Octavian, and Lepidus	43 BC
Triumvirate is defeated at Philippi in eastern Macedon	42 BC
The Ptolemaic Kingdom is conquered by Rome	39 BC
The country is annexed by Octavian Caesar as a province if Rome following the defeat of Mark Antony and Cleopatra	31 BC
The last Olympic games in ancient Greece	393 AD

References

(no date) Anticopedie. The inventions and technology of the ancient Greeks. Educational Resources on the Ancient Mediterranean World. Retrieved October 3, 2024 from https://anticopedie.fr/download/technologies-gb.pdf.

Apostol, Tom M. (2004). The Tunnel of Samos. Engineering and Science No. I.

Betts, Jonathan D. (2019 Aug 5). "clepsydra". *Encyclopedia Britannica*, https://www.britannica.com/technology/clepsydra. Accessed 4 October 2024.

(no date) Blevins, Brian S. and Danial L. Perry. Early History of Surveying. Utah Valley University. Retrieved December 30, 2024 from https://storymaps.arcgis.com/stories/06ab92191f9f41ecb0ecb3377874cc8b.

Brock, John (2004). Pyramids to Pythagoras: Surveying from Egypt to Greece – 2000 B.C. to 100 A.D. FIG Working Week 2004 (workshop). Athens, Greece.

Cartwright, M. (2017 December 20). Ancient Greek Inventions. World History Encyclopedia. Retrieved July 18, 2024 from https://www.worldhistory.org/article/1165/ancient-greek-inventions/.

(no date) Wikipedia. *History of Greece*. Wikipedia: The Free Encyclopedia. Retrieved July 17, 2024 from https://en.wikipedia.org/wiki/History_of_Greece.

(no date) Wikipedia. *Ancient Greek Technology*. Wikipedia: The Free Encyclopedia. Retrieved July 17, 2024 from https://en.wikipedia.org/wiki/Ancient_Greek_technology.

(no date) Wikipedia. *Ancient Greece*. Wikipedia: The Free Encyclopedia. Retrieved June 29, 2024 from https://en.wikipedia.org/wiki/Ancient_Greece.

(no date) Wikipedia. *Ancient Greek Cuisine* Wikipedia: The Free Encyclopedia. Retrieved November 2, 2024 from https://en.wikipedia.org/wiki/Ancient_Greek_cuisine.

(no date) Wikipedia. *Library of Alexandria*. Wikipedia: The Free Encyclopedia. Retrieved August 11, 2024 from https://en.wikipedia.org/wiki/Library_of_Alexandria.

(no date) Wikipedia. *Marriage in ancient Greece*. Wikipedia: The Free Encyclopedia. Retrieved November 20, 2024 from https://en.wikipedia.org/wiki/Marriage_in_ancient_Greece.

(no date) Wikipedia. *Parthenon*. Wikipedia: The Free Encyclopedia. Retrieved October 21, 2024 from https://en.wikipedia.org/wiki/Parthenon.

History.com Editors (2010 March 5). *Ancient Greece*. Retrieved July 4, 2024 from https://www.history.com/topics/ancient-greece/ancient-greece.

Smith, Chris (2021 October 29). *10 Key Inventions and Innovations of Ancient Greece*. History Hit. Retrieved December 21, 2024 from https://www.historyhit.com/inventions-and-innovations-of-ancient-greece/.

Koutsoyiannis, Demetris (2007). *Water technology and management in Ancient Greece*: Legacies and lessons. National Technical University of Athens, School of Civil Engineering. Athens, Greece.

Mark, J.J. (2013 November 13). *Ancient Greece. World History Encyclopedia*. Retrieved July 4, 2024 from https://www.worldhistory.org/greece/.

McFadden, Christopher (2018 November 22). *13 Engineers From Antiquity And Their Marvels. Interesting Engineering*. Retrieved November 21, 2024 from https://interestingengineering.com/innovation/13-engineers-from-antiquity-and-their-marvels.

Museum of Ancient Greek Technology (2024). Katakolo Ilias. Retrieved December 20, 2024 from https://kotsanas.com/en/home-en/.

(no date) National Geographic Kids. *10 Facts about Ancient Greece*. National Geographic. Retrieved July 4, 2024 from https://www.natgeokids.com/uk/discover/history/greece/10-facts-about-the-ancient-greeks/.

(no date) Metropolitan Museum of Art. *Heilbrunn Timeline of Art History*. Retrieved July 4, 2024 from https://www.metmuseum.org/toah/ht/04/eusb.html.

Palcis, Raul (2023 May 9). *The Enduring Legacy of Greek Architecture and Engineering: How Ancient Innovations Shaped Modern Design*. Retrieved October 6, 2024 from https://www.researchgate.net/publication/370629597_The_Enduring_Legacy_of_Greek_Architecture_and_Engineering_How_Ancient_Innovations_Shaped_Modern_Design.

(no date) University of Wisconsin – Madison. *Ancient Engineering Technologies – Water Systems*. Department of Civil Engineering. Retrieved September 23, 2024 from https://ancientengrtech.wisc.edu/greece-overview/water-systems/.

Vyas, Kashyap (2023 April 26). 11 Greek Inventions That Changed the World for Good. Interesting Engineering. Retrieved December 20, 2024 from https://interestingengineering.com/lists/11-greek-inventions-that-changed-the-world-for-good.