Technology and the World

- **The development of the staggering amount of technology over the last 100 years and the direction of world progress are inextricably tied together.**
- **World events can have a profound effect on technology development and technology, as the history of some or our world conflicts have shown.**
- **Conversely, the effect of technology on world events has been equally profound, and the use of technology in some of the major wars in the history of the world have both shortened – and prolonged – those wars.**

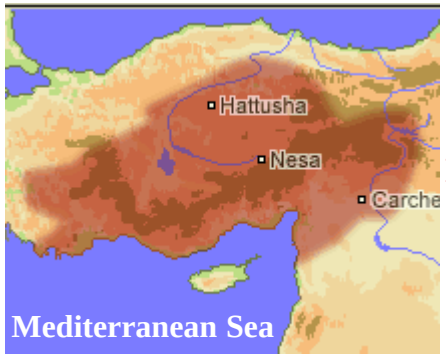
Genghis Khan: Technologist

- **An early adopter of leading-edge technology was Genghis Khan and his Mongol armies in the 12th century.**
- **Though not technology developers themselves, the Mongol conquerors of much of 12th-century Asia and Europe were quick to recognize new technology developments as they encountered them in the road to conquest.**
  - **Mongol armies were among the first to use precursors of modern mortars and cannons to damage walled cities being besieged.**
  - **They used a mobile attack method employing horse cavalry, a variant of the *blitzkrieg* of the German army in WW II.**
  - **The Mongol army carried no supply train or siege engines, but had "staff engineers" that designed and built them on-site (!).**

The Hittites and the Technology of Iron Use

- The Hittites (see map) started building an empire as early as about 1900 BC. It expanded into Asia Minor, northern Syria, and ended with the conquest of Babylon.
- The Hittites began to extract iron from ore, making the first iron weapons and gaining a huge advantage in battle for their warriors.
- Iron blades were heated until red-hot, impurities were beaten out, and they were plunged into cold water to harden, making the edges stronger and sharper than bronze or copper weapons.
- Iron technology was so important that the Hittites tried to keep it secret. However, as their empire collapsed (~1200 BC), the new knowledge began to spread, thus ushering in the Iron Age.

1700 BC

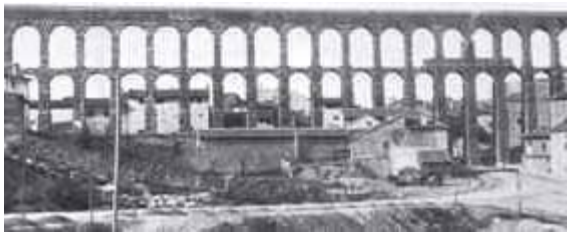


1400 BC

The Hittite Empire reached its height in about 1400 BC

Rome: Great Engineering with a Really Bad System of Math

- The first great engineers were probably the Eqyptians, with their awe-inspiring pyramids.
- Another great engineering civilization was the Roman Empire. As an example, Roman engineers supplied Rome with water using a system of 640 kilometers of aqueducts.
- The aqueduct at Segovia in Spain is 60 meters high in places. It has survived 2000 years, a testament to the engineering skills of Rome.
- Another example of Rome's engineering skill has the be the numerous Roman roads that still exist all over western Europe.
- The "Roman baths" in Bath, England are a great example of the plumbing skills of Rome.

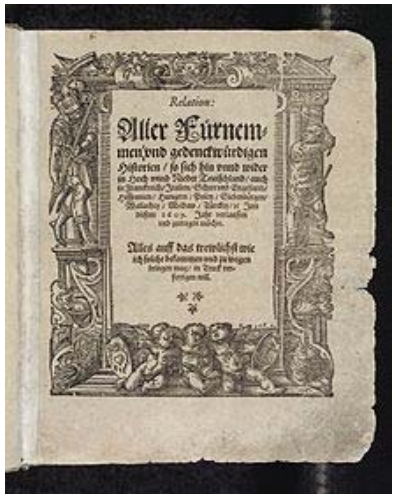


Roman Aqueduct in Segovia, Spain

Roman baths in Bath, England

Cheap Paper and the Printer: A Revolution in Communication

- Paper making began in China around 100 AD. The technology gradually spread; inexpensive paper was available in Europe by the 1400's.
- Johannes Gutenberg (~1394-1468), a German inventor, is best known for developing the first printing press using movable type.
- In 1438, Andreas Dritzehn funded Gutenberg's experiments in printing. By1450, Gutenberg had a second arrangement with Johannes Fust, a German businessman. Gutenberg started a printing business and built his Gutenberg Press.
- His printing projects included the now famous Gutenberg Bible, published in September, 1452 (the first book to be published in volume).

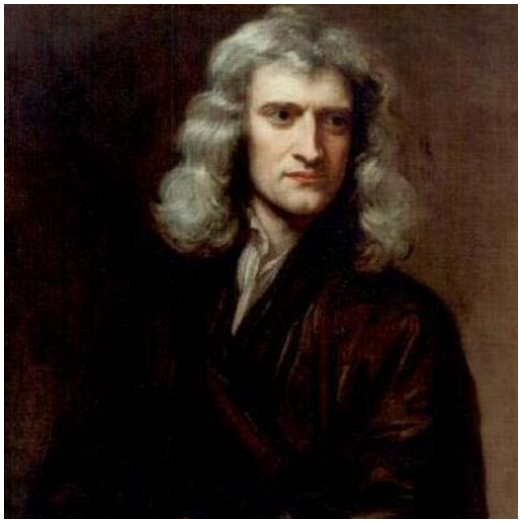


An early newspaper.


Gutenberg and his printer.

The Seventeenth Century: Scientific Foundations

- **Much fundamental research took place in the 1600's, which lay the technological foundations of engineering.**
- **The great scientific mind of the day, Sir Isaac Newton developed many mathematical techniques and also laid the foundations of modern physics.**
- **The scientific revolution was already in full flower when he arrived on the scene – astronomers Nicholas Copernicus and Johannes Kepler were already active.**
- **Probably his greatest contribution to science is the Calculus, which laid the basis for most modern mathematics.**

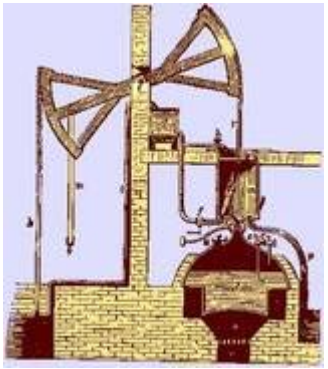


Sir Isaac Newton

The 18th Century: Industrial Revolution!

- **The eighteenth century saw much new technology.**
  - **In 1712, Newcomen patented an early steam engine.**
  - **In the early 1700's, the fire extinguisher, diving bell, and mercury thermometer were invented.**
  - **In 1745, E.G. von Kleist invented the leyden jar, the first electrical capacitor.**
  - **Later, James Hargreaves invented the spinning jenny.**
  - **James Watt's improved steam engine came in 1769.**
  - **In the late 1700's both the gas turbine and bicycles were invented.**

Hargreave's Spinning Machine



Newcomen's Steam Enginer

The Nineteenth Century: Technology Accelerates

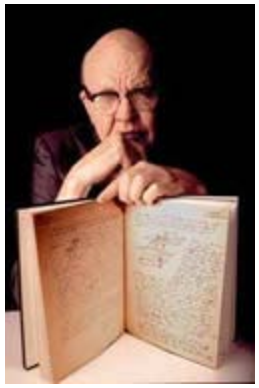
- **The nineteenth century was the era of manufacturing technology:**
  - **1809 – Electric are lamp (first electric light)**
  - **1824 – Portland cement (basis of concrete)**
  - **1829 – Typewriter**
  - **1830 – Sewing machine**
  - **1840 – The blueprint**
  - **1855 – Rayon synthetic fabric**
  - **1862 – Plastic**
  - **1866 – Dynamite (Nobel)**
  - **1876 – Telephone (Bell) and internal combustion engine (Otto)**
  - **1885 – Automobile (Benz)**
  - **1888 – Electric motor and transformer (Tesla)**

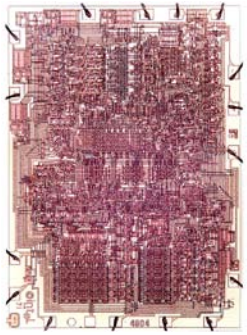
The typewriter was also invented in the 1800's.

The Twentieth Century: Technology Explosion

- **The twentieth century saw a technological explosion, with the invention of far too many things to enumerate, from corn flakes to the airplane to the air conditioner to penicillin.**
- **For that reason, we mention only very significant electrical engineering inventions of the last century. These include radio broadcasting (1922; radio invented in 1879), television (1924), the microwave oven (1945), the transistor (1948), the integrated circuit (1958), the laser (1960), the video game (1968), the Arpanet (forerunner of the internet/world wide web) (1969), the microprocessor (1971), the compact disc (1980), and the GPS (1993).**

Kilby and his circuit.





The Intel 4004

A Major Technology Driver: War

- Over the history of mankind, war has been a prime driver of technology as we have seen in the technology adaptations of the Mongols, Hittite iron weapons, Roman roads for their armies, and so forth.
- This continued into the 20th century, as conflict (think WW II) drove engineering development, such as jet aircraft and nuclear and thermonuclear bombs.
- However, particularly in the last 60 years, technology development has continued outside the influence of the military, and we now see that technology may be beginning to drive world events as well.

Technology as History Changer

- As technology development (especially in EE) has blossomed, dictatorships and states with "central governments" are finding it hard to control the population when everyone has access to the internet and mobil communications.
- Even politicians in "free societies" are finding it hard to fool or lie to their constituencies or get away with fraud in terms of their representative activities.
- We see that technology, especially communications technology, is making the world a better place, where leaders have to answer to their public.

Technology and Change Today

- **Today, one of the major technology/world (environmental) interactions is global warming.**
- **This is a two-way street:**
  - **Older technology may be leading to a serious increase in "greenhouse gases," which may in turn lead to a dangerous increase in the surface temperature of our planet.**
  - **And yet, the application of newer and "greener" technology may be able to ameliorate the climate effects, heading off the possibly cataclysmic effects which are described (in terrifying detail) by the more militant of the climate change proponents.**

A Political Hot Potato

- **Global warming (or climate change) is a serious subject today, claiming more headlines than any other issue before the world except, perhaps, a few of its conflicts.**
- **In the US, political movements have conscripted believers into opposite armies – the "doom and gloom" global warming disaster crew, and the "there's nothing whatever wrong" opposition.**
- **Technology may be causing this problem – and perhaps it can also avoid it. What do you think?**

"Global Warming"

- "Global warming" has been in the news for ~two decades now. (Some proponents now use the term "climate change," which sounds more politically correct.)
- The assertion is that the earth is gradually getting warmer, due to the "greenhouse gases" (primarily CO_2) that is increasing due to human activity.
- It is certainly true that several gases such as water vapor (H_2O), as well as CO_2, effect the heat retention of the atmosphere positively.
- Some of this is a good thing, as warmer temperatures help us survive on the surface of the earth.

The "Greenhouse Effect"

- **Our atmosphere is transparent to sunlight (apart from the significant reflectivity of clouds and the surface), which heats the Earth's surface.**
- **The surface offsets that heating by radiating in the infrared. Infrared radiation increases with increasing surface temperature; the temperature adjusts until balance is achieved.**
- **Infrared radiation of the earth surface should balance incoming solar radiation (less that amount reflected back to space by clouds).**
- **Unfortunately, the atmosphere is not transparent to infrared. Thus, the Earth must heat up additionally to deliver an equal amount of infrared radiation back to space. This is the "greenhouse effect."**

"Facts" – The State of Our Knowledge*

- **Human activities that increase greenhouse gases in the atmosphere since pre-industrial times are well-documented and understood.**
- **The atmospheric buildup of CO_2 and other greenhouse gases is largely the result of human activities such as burning of fossil fuels.**
- **A definite warming of ~1.0-1.7 °F occurred from 1906-2005. Warming occurred in Northern and Southern Hemispheres and over the oceans (Intergovernmental Panel on Climate Change [IPCC], 2007).**
- **Greenhouse gases emitted by human activities remain in the atmosphere for decades to centuries. Thus, concentrations of greenhouse gases will continue to rise in the atmosphere.**
- **Increasing greenhouse gases tend to warm the planet.**

***Most of the following information comes from the website of the Environmental Protection Agency**

EPA – "What's Likely?"

- **The IPCC has stated: "Most observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic (human) greenhouse gas concentrations."**
- **A growing number of scientific analyses indicate, but cannot prove, that rising levels of greenhouse gases in the atmosphere are contributing to climate change ("as theory predicts").**
- **As atmospheric concentrations of greenhouse gases continue to rise, average global temperatures and sea levels will continue to rise as a result and precipitation patterns will change.**

EPA: "What is Not Certain"

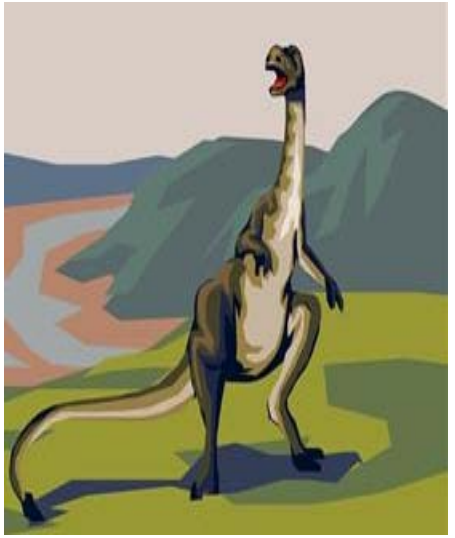
- **Important scientific questions remain: How much warming will occur, how fast it will occur, and how will warming affect the rest of the climate system, including precipitation patterns and storms?**
- **Answering these questions will require scientific advances:**
  - **Improving understanding of natural climatic variations, changes in the sun's energy, and other environmental impacts.**
  - **Determining the relative contribution of human activities.**
  - **Projecting future greenhouse emissions and climate response.**
  - **Understanding the potential for rapid or abrupt climate change.**

The Past

- **During the last 2,000 years, climate has been relatively stable. Scientists have identified three variations: the Medieval Warm Period, the Little Ice Age and the Industrial Era:**
  - **The Medieval Warm Period: From ~ 900-1300 AD, Europe, Greenland and Asia experienced relative warmth. The extent and timing of the warmth is uncertain. The American West was very dry around this time.**
  - **The Little Ice Age: A "Little Ice Age" (average temperatures were up to 2ºF colder than today) occurred between about 1500 and 1850.**
  - **The Industrial Era: An additional warm period has occurred in the last 100 years, coinciding with increasing emissions of greenhouse.**

Pre-Civilization Climate Change Causes

- **Changes in the Earth's orbit as well as the Earth's tilt and precession affect the amount of sunlight received on the Earth's surface. These orbital processes (cycles) of 100,000 (eccentricity), 41,000 (tilt), and 19,000 to 23,000 (precession) years are thought to be significant drivers of ice ages according to the theory of Mulitin Milankovitch, a Serbian mathematician (1879-1958).**
- **Changes occurring inside the sun can affect the sunlight that reaches the Earth's surface. Intensity of the sunlight can cause either warming (stronger solar intensity) or cooling (weaker solar intensity).**
- **According to NASA research, reduced solar activity from the 1400s to the 1700s was likely a key factor in the "Little Ice Age."**



Pre-Civilization Changes (2)

- **Volcanic eruptions: Volcanoes can affect climate due to emissions.**
  - **Aerosols: Aerosols (particles) block sunlight and cause short-term cooling. They do not produce long-term change due to short duration in the air.**
  - **According to the US Geological Survey, the eruption of the Tambora Volcano in Indonesia in 1815 lowered global temperatures by as much as 5ºF and led to "the year without a summer" in New England.**
  - **Carbon dioxide emissions: Volcanoes also emit CO_2, a greenhouse gas. For about two-thirds of the last 400 million years, geologic evidence suggests CO_2 levels and temperatures were considerably higher than present.**

Pre-Civilization Changes (3)

- **Volcanic emissions (continued):**
  - **One theory is that volcanic eruptions from rapid sea floor spreading elevated CO_2 concentrations, enhancing the greenhouse effect and raising temperatures.**
  - **Evidence for this theory is not conclusive and there are alternative explanations for historic CO_2 levels.**
  - **While volcanoes may have raised pre-historic CO_2 levels and temperatures, according to the USGS Volcano Hazards Program, human activities now emit 150 times as much CO_2 as volcanoes (whose emissions are relatively modest today compared to some earlier times).**

The Near Past

- **Since the Industrial Revolution (~1750), human activities have increased greenhouse gases in the atmosphere. Burning of fossil fuels and biomass (such as vegetation) has also resulted in emission of aerosols.**
- **Addition of greenhouse gases and aerosols has changed the composition of the atmosphere. Changes in the atmosphere have likely influenced temperature, precipitation, storms and sea level.**
- **However, these features of the climate also vary naturally, so determining what fraction of climate changes are due to natural variability versus human activities is challenging.**

Future Changes (?)

- **Greenhouse gas concentrations in the atmosphere will increase during the next century unless greenhouse gas emissions decrease substantially from present levels.**
- **Increased greenhouse gas concentrations are very likely to raise the Earth's average temperature, influence precipitation and some storm patterns, and raise sea levels (IPCC, 2007). The magnitude of these changes, however, is uncertain.**

Future Changes? (2)

- **The amount and speed of future climate change will ultimately depend on:**
  - **Whether greenhouse gases and aerosol concentrations increase, stay the same or decrease.**
  - **How strongly temperature, precipitation, and sea level respond to changes in greenhouse gas and aerosol concentrations.**
  - **How much climate varies due to natural influences (e.g. volcanic activity and changes in the sun's radiation) and its internal variability (e.g., random changes in circulation of the atmosphere and oceans).**

Climate Models

- **Virtually all estimates of climate change in the future are made by computer models of the Earth's climate system. These models are known as general circulation models (GCMs).**
- **According to the IPCC (2007):**
  - **"[Climate] Models have proven to be extremely important tools for simulating and understanding climate. There is considerable confidence that they are able to provide credible quantitative estimates of future climate change, particularly at larger scales.**
  - **Models continue to have significant limitations, such as in their representation of clouds…**

Climate Models (2)

- **Over several decades of model development, [climate models] have consistently provided a robust and unambiguous picture of significant climate warming in response to increasing greenhouse gases.**
- **It is important to recognize that projections of climate change in specific areas are not forecasts comparable to tomorrow's weather forecast.**
- **Rather, they are hypothetical examples of how the climate might change and usually contain a range of possibilities as opposed to one specific high likelihood outcome.**

Objections* – A History

- Studies from the nineteenth century-on suggested that industrial and other contributions to increasing carbon dioxide might lead to global warming.
- There were problems with such predictions, and their general failure to explain the observed record caused the field of climatology as a whole to dismiss the suggested mechanisms.
- A global cooling trend in the late 1950s and 1960s led to a minor global cooling hysteria in the 1970s. The cooling hysteria had striking analogues to the present warming hysteria, including books such as The Genesis Strategy by Stephen Schneider and Climate Change and World Affairs by Crispin Tickell.

* Much of this data comes from the Cato Institute

History (2)

- **A book by prominent science writer Lowell Ponte (The Cooling) derided skeptics and noted the importance of acting in the absence of firm, scientific foundation.**
- **The scientific community never took the issue to heart, governments ignored it, and rising global temperatures in the late ‘70s killed the issue.**
- **In the meantime, institutes such as the Geophysical Fluid Dynamics Laboratory at Princeton continued to predict substantial warming due to increasing carbon dioxide. This was considered interesting, but largely academic, even by the scientists involved.**

History (3)

- **The present hysteria began in the summer of 1988, although preparations had been put in place at least three years earlier. That was an especially warm summer, particularly in the United States.**
- **The abrupt increase in temperature in the late 1970s was too abrupt to be associated with the smooth increase in carbon dioxide.**
- **Nevertheless, James Hansen, director of the Goddard Institute for Space Studies, in testimony before Sen. Al Gore's Committee on Science, Technology and Space, said, in effect, that he was 99 percent certain that temperature had increased due to greenhouse warming. He made no statement concerning the lack of correlation to actual data.**

History (4)

- **The environmental advocacy movement adopted the issue immediately, despite the scientific basis of the remarks.**
- **The growth of environmental advocacy since the 1970s has been phenomenal. In Europe the movement centered on formation of Green parties; in the US, it centered on the development of large public interest advocacy groups.**
- **Those lobbying groups have budgets of several hundred million dollars and employ ~50,000 people; their support is highly valued by political figures. As with any large groups, self-perpetuation becomes crucial. "Global warming" has become one of the major battle cries in their fundraising efforts. At the same time, the media unquestioningly accept the pronouncements of those groups as objective truth.**

Summary of Objections

- **Models exaggerate the response to increasing carbon dioxide; their predictions for the past century incorrectly describe the pattern of warming and greatly overestimate its magnitude.**
- **One global warming advocate, Michael McElroy, head of the Department of Earth and Planetary Sciences at Harvard, recently wrote a paper acknowledging that existing models cannot be used to forecast climate.**
- **The National Research Council in the United States prepared a synthesis of the current state of the global change situation.**
- **The report concluded that the scientific basis for costly action was absent, although prudence might indicate that actions that were cheap or worth doing anyway should be considered.**
- **"…equally unsurprising is the fact that the New York Times typically carried reports on that panel on page 46."**

Summary (2)

- There is growing skepticism by many scientists about global warming, at least some of the more dire predictions.
- Indeed, some scientists have changed sides in this argument.
- Moreover, some industries have become successful at profiting from environmental regulation. The most obvious example is the waste management industry.
- Even electric utility companies have been able to use environmental measures to increase the base on which their regulated profits are calculated.
- It is worth noting that about 1.7 trillion dollars have been spent on the environment over the past decade. The environment, itself, qualifies as one of our major industries.

Summary and Assignment

- Technology and our world interact continually.
- That interaction can be for ill or for good.
- In the case of climate change, the effect of technology to date seems mixed, and the outcome unclear.
- Teams: Prepare a report that researches climate change.
  - Three slides (professional, polished, succinct).
  - Three minute presentation, four maximum.
  - Eight-ten page report (including illustrations, but at least five pages of text, double-spaced).
  - State your conclusion. Have facts and solid sources to back up your conclusion.* Carefully defend your position.
  - You may also approach the issue from the "importance of conservation" direction.

* Not Wikipedia!

Notes on Your Presentation

- **Have your team number and EE 1202 section on each slide, and the team members list on the cover slide (does not count as a presentation slide).**
- **Turn in a copy of the slides plus your report.**
- **Two presenters at most.**
- **Actual time of presentation ≈ 3 minutes! The other one minute period is allotted to get to the front, insert your media, and prepare to speak.**
- **Next team always be lined "in the wings."**
- **We will go straight through in order of team number.**