LIVES IN EDUCATION

John Scales Avery

May 22, 2020

INTRODUCTION[1]

Human history as cultural history

We need to reform our teaching of history so that the emphasis will be placed on the gradual growth of human culture and knowledge, a growth to which all nations and ethnic groups have contributed.

This book is part of a series on cultural history. Here is a list of the other books in the series that have, until now, been completed:

- Lives in Poetry
- Lives in Painting
- Lives in Engineering
- Lives in Astronomy
- Lives in Chemistry
- Lives in Medicine
- Lives in Ecology
- Lives in Physics
- Lives in Economics
- Lives in the Peace Movement

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The long human childhood

When a baby antelope is born, it staggers unsteadily to its feet, but after a few minutes it is able to follow its mother and the herd. Contrast this with the complete helplessness of a human baby! As our society becomes more and more complex and knowledge-based, the period of dependency of young humans has become almost absurdly long. In medicine and the sciences,

[1]This book makes use of chapters and articles that I have previously written, but most of the material is new

many years of postgraduate training are required, and often young people are in their early thirties before they are fully qualified.

But education is an investment that gives dividends. The life of a "knowledge worker" is extremely interesting and rewarding.

Knowledge-based economies

Economic activity is usually divided into two categories, 1) production of goods and 2) provision of services. It is the rate of production of goods that will be limited by the carrying capacity of the global environment. Services that have no environmental impact will not be constrained in this way. Thus a smooth transition to a sustainable economy will involve a shift of a large fraction the work force from the production of goods to the provision of services.

Within the service sector, many jobs involve a high degree of education. "Knowledge workers", for example computer programmers, physicians, pharmacists, architects, engineers, scientists, design thinkers, public accountants, lawyers, and academics, are those whose personal capital consists of a high degree of education. They think for a living; and their activities have very small ecological footprints.

In his recent popular book *The Rise of the Creative Class*, the economist Richard Florida points out that in a number of prosperous cities - for example Stockholm - a large fraction of the population is already engaged in what might be called creative work - a type of work that uses few resources, and produces few waste products - work which develops knowledge and culture rather than producing material goods. For example, producing computer software requires few resources and results in few waste products. Thus it is an activity with a very small ecological footprint. Similarly, education, research, music, literature and art are all activities that do not weigh heavily on the carrying capacity of the global environment. Florida sees this as a pattern for the future, and maintains that everyone is capable of creativity. He visualizes the transition to a sustainable future economy as one in which a large fraction of the work force moves from industrial jobs to information-related work.

Culture, education and human solidarity

Since culture and knowledge are shared among all nations, work in culture and education leads societies naturally towards internationalism and peace.

Economies based on a high level of consumption of material goods are unsustainable and will have to be abandoned by a future world that renounces the use of fossil fuels in order to avoid catastrophic climate change, a world where non-renewable resources such as metals will become increasingly rare and expensive.

How then can full employment be maintained? The creation of renewable energy infrastructure will provide work for a large number of people; but in addition, sustainable economies of the future will need to shift many workers from jobs in industry to jobs in the service sector.

Within the service sector, jobs in culture and education are particularly valuable because they will help to avoid the disastrous wars that are currently producing enormous human suffering and millions of refugees, wars that threaten to escalate into an all-destroying global thermonuclear war.

Human nature has two sides: It has a dark side, to which nationalism and militarism appeal; but our species also has a genius for cooperation, which we can see in the growth of culture.

Our modern civilization has been built up by means of a worldwide exchange of ideas and inventions. It is built on the achievements of many ancient cultures.

In the teaching of history, our common global culture, the music, science, literature and art that all of us share, should be presented as a precious heritage far too precious to be risked in a thermonuclear war.

We have to extend our loyalty to the whole of the human race, and to work for a world not only free from nuclear weapons, but free from war.

A war-free world is not utopian but very practical, and not only practical but necessary. It is something that we can achieve and must achieve.

Today there are large regions, such as the European Union, where war would be inconceivable. What is needed is to extend these.

Nor is a truly sustainable economic system utopian or impossible. To achieve it, we should begin by shifting jobs to the creation of renewable energy infrastructure, and to the fields of culture and education.

By so doing we will support human solidarity and avoid the twin disasters of catastrophic war and climate change.

Contents

Chapter 1

THE ACADEMIES OF PLATO AND ARISTOTLE

1.1 The Minoans

Histories of the development of western civilization usually begin with the Greeks, but it is important to remember that the Greek culture was based on the much earlier civilizations of Mesopotamia and Egypt. The cultural achievements of these very early civilizations were transmitted to the Greeks in part through direct contact, and in part through the Minoan and Mycenaean civilizations.

The Minoan civilization on Crete is the civilization which is familiar to us through the legends of Theseus, the Minotaur and the Labyrinth, and the legend of Daedalus and Icarus. Apart from the Greek legends, whose truth was doubted, nothing was known about the Minoan civilization until 1900. In that year, the English archaeologist, Sir Arthur Evans, began to dig in a large mound at Knossos on Crete. What he uncovered was a palace of great beauty which, to his astonishment, seemed once to have boasted such conveniences as hot and cold running water and doors with metal locks and keys. Sir Arthur Evans considered this to represent the palace of the legendary King Minos.

The Minoan civilization seems to have been based not on agriculture, but on manufacture and on control of the Mediterranean sea trade. It flourished between 2,600 B.C. and 1,400 B.C.. In that year, the palace at Knossos was destroyed, and there is evidence of scattered looting. Other evidence shows that in about 1,400 B.C., a nearby island called Thera exploded in a volcanic eruption of tremendous violence; and probably this explosion, combined with an invasion of Mycenaeans, caused the end of the Minoan civilization. The palace at Knossos was inhabited later than 1,400 B.C., but the later people spoke Greek.

The Minoan civilization, as shown in the graceful works of art found at Knossos, seems to have been light-hearted and happy. The palace at Knossos was not fortified and was apparently protected by sea power. Women's dresses on ancient Crete looked a bit like the dresses which were popular in Europe during the 1900's, except that they left the breasts bare. Some of the wall paintings at Knossos show dances and bull-fights. In the bull-fights, the bull was not killed. The bull-fighter was an acrobat, often a girl, who seized the lowered horns of the charging bull and was tossed in a somersault over its back.

1.2 The Mycenaean civilization

The Mycenaean civilization developed at Troy, Mycenae (the home of the legendary Agamemnon), and other sites around the Aegean Sea. It is the civilization familiar to us through the stories of Ulysses, Priam, Ajax, Agamemnon, Paris and Helen. Like the Minoan civilization, the Mycenaean culture was thought to be purely legendary until quite recent times. We now know that the Homeric epics have a basis in fact, and this surprising revelation is mainly due to the work of a brilliant businessman-turned-archaeologist named Heinrich Schliemann.

As a young (and poor) boy, Schliemann was inspired by reading Homer's Iliad, and he decided that when he grew up he would find the site of ancient Troy, which most people considered to be a figment of Homer's imagination. To do this, he first had to become very rich, a task which he accomplished during the first 45 years of his life.

At last he had accumulated a huge fortune, and he could follow the dream of his boyhood. Arriving in Greece, Schliemann put an advertisement into a newspaper describing himself and saying that he needed a wife. This was answered by a beautiful and intelligent Greek girl, whom he promptly married.

Aided by armies of excavators, his beautiful wife, his brilliant intellect and a copy of Homer, Schliemann actually succeeded in unearthing ancient Troy at a site in Asia Minor! At this site, he uncovered not one, but nine ancient cities, each built on the ruins of the last. He also found beneath the walls of Troy a treasure containing 8,750 pieces of gold jewelry, which he considered to be King Priam's treasure. He went on to uncover many other remains of the Mycenaean civilization at sites around the Aegean.

Schliemann's discoveries show the Mycenaeans to have been both technically and artistically accomplished. They spoke an Indo-European language (a form of Greek), and they were thus linguistically related to the tribes which conquered Persia, India and Europe.

The Mycenaean civilization lasted until about 1,075 B.C.. Between that date and 850 B.C., the Greek-speaking peoples of the Aegean entered a dark age. Probably the civilized Mycenaeans were conquered by fresh waves of semi-primitive Greek-speaking tribes from the north.

It is known that the Greeks arrived in the Aegean region in three waves. The first to come were the Ionians. Next came the Achaeans, and finally the Dorians. Warfare between the Achaeans and the Ionians weakened both groups, and finally they both were conquered by the Dorians. This conquest by the semi-primitive Dorians was probably the event which brought the Mycenaean civilization to an end. At any rate, during the dark ages between 1,075 B.C. and 850 B.C., the art of writing was lost to the Greeks, and the level of artistic and cultural achievement deteriorated.

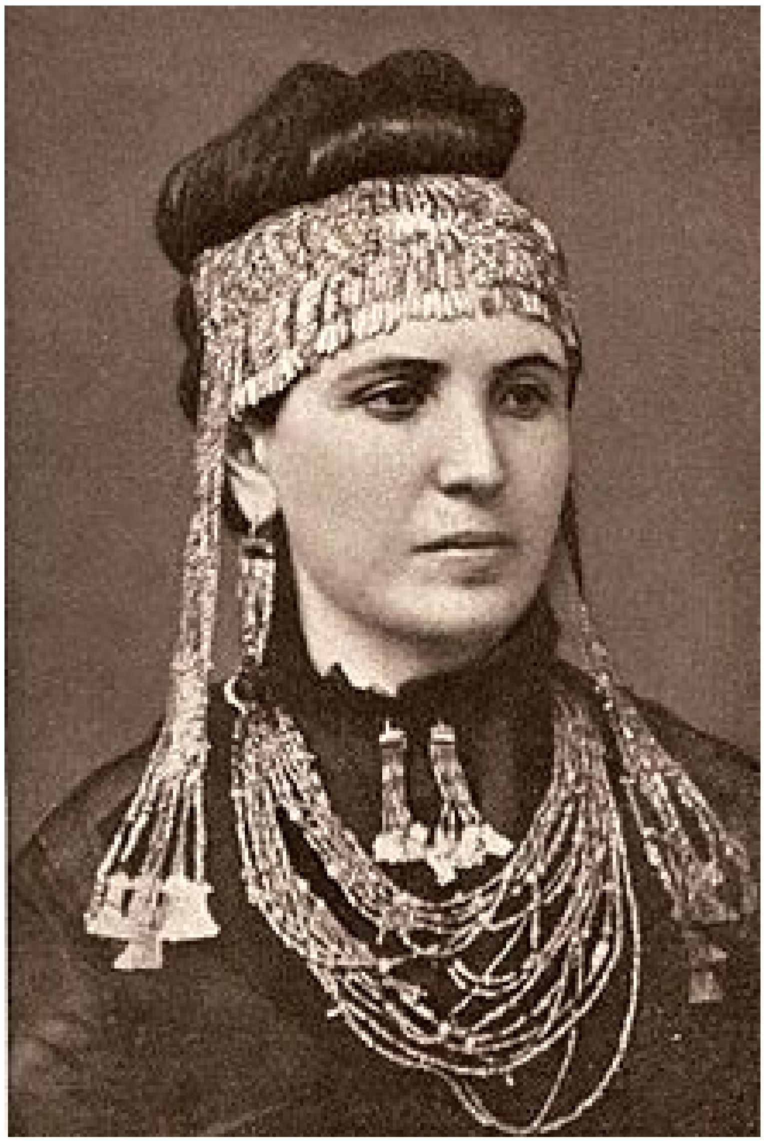

Figure 1.1: **Sophia Schliemann (née Engastromenos) wearing treasures recovered at Hisarlik (Troy).**

1.3 Thales of Miletus

Beginning in about 850 B.C., there was a rebirth of Greek culture. This cultural renaissance began in Ionia on the west coast of present-day Turkey, where the Greeks were in close contact with the Babylonian civilization. Probably the Homeric epics were written in Miletus, a city on the coast of Asia Minor, in about 700 B.C.. The first three philosophers of the Greek world, Thales, Anaximander and Anaximenes, were also natives of Miletus.

Thales was born in 624 B.C. and died in 546 B.C.. The later Greeks considered him to have been the founder of almost every branch of knowledge. Whenever the wise men of ancient times were listed, Thales was invariably mentioned first. However, most of the achievements for which the Greeks admired Thales were probably not invented by him. He is supposed to have been born of a Phoenecian mother, and to have travelled extensively in Egypt and Babylonia, and he probably picked up most of his knowledge of science from these ancient civilizations.

One of the achievements which made Thales famous was his prediction of a solar eclipse which (according to modern astronomers) occurred on May 28, 585 B.C.. On the day of the eclipse, the Medes and the Lydians were about to begin a battle, but the eclipse convinced them that they ought instead to make peace and return home. Thales predicted, not the exact day, but only the year in which the eclipse would occur, but nevertheless the Greeks were impressed. The astronomical knowledge which allowed him to make this prediction was undoubtedly learned from the Babylonians, who had developed a system for the accurate prediction of lunar eclipses two centuries earlier.

Thales brought Egyptian geometry to Greece, and he also made some original contributions to this field. He changed geometry from a set of *ad hoc* rules into an abstract and deductive science. He was the first to think of geometry as dealing not with real lines of finite thickness and imperfect straightness, but with lines of infinitesimal thickness and perfect straightness. (Echoes of this point of view are found in Plato's philosophy).

Thales speculated on the composition of matter, and decided that the fundamental element is water. He thought this because animals can live by eating plants, and plants (Thales mistakenly believed) can live on water without any other nourishment.

Many stories are told about Thales. For example, Aristotle says that someone asked Thales, "If you're so wise, why aren't you rich?" Thales was offended by this question, and in order to prove a point, he quietly bought up all the olive presses of the city during the winter of a year when his knowledge of weather told him that the olive harvest would be exceptionally large. When summer came, the harvest was enormous, and he was able to rent the presses at any price he liked to charge. He made himself rich in one season, and then went back to philosophy, having shown that philosophers could easily be rich if they liked, but they have higher ambitions than wealth.

Another story is told about Thales by Plato. According to Plato, Thales was so interested in some astronomical observations which he was making that he failed to look where he was going and fell into a well. He was helped out by a pretty and clever serving maid from Thrace who laughed at him because he was so interested in the stars that he could not see things that were right under his feet!

Figure 1.2: **The Ionic Stoa on the Sacred Way in Miletus.**

Thales had a student named Anaximander (610 B.C. - 546 B.C.) who also helped to bring Egyptian and Babylonian science to Greece. He imported the sundial from Egypt, and he was the first to try to draw a map of the entire world. He pictured the sky as a sphere, with the earth floating in space at its center. The sphere of the sky rotated once each day about an axis passing through the polar star. Anaximander knew that the surface of the earth is curved. He deduced this from the fact that as one travels northward, some stars disappear below the southern horizon, while others appear in the north. However, Anaximander thought that a north-south curvature was sufficient. He imagined the earth to be cylindrical rather than spherical in shape. The idea of a spherical earth had to wait for Pythagoras.

The third philosopher in the school of Miletus was Anaximenes (570 B.C. - 500 B.C.), a pupil of Anaximander. He was the first of the Greeks to distinguish clearly between the planets and the stars. Like Thales, he speculated about the composition of matter, and he concluded that the fundamental element was air. This (he thought) could be compressed to form water, and still further compressed to form earth. Thus Anaximenes conceived in principle the modern idea of the three states of matter: gas, liquid and solid, which change into one another as the pressure and temperature are changed.

1.4 Pythagoras

Pythagoras, who lived from 582 B.C. to 497 B.C., is one of the most important and interesting figures in the history of European culture. It is hard to decide whether he was a religious leader or a scientist. Certainly, in order to describe him, one has to say a little about the religion of ancient Greece.

Besides the official religion, the worship of the Olympian gods, there were also other cults which existed simultaneously, and among these the worship of Bacchus or Dionysus was the most important. Bacchus, Dionysus and Bromios were all names of a many-named Thracian god who represented the forces of nature. The worshippers of Dionysus tried to return to nature, gaining release from the tensions generated by civilization by casting off all civilized constraints and returning temporarily to an animal-like state, reviving long-suppressed instincts. Often the worshippers were women, young girls and slaves, who gathered on the mountain slopes on certain evenings and began to dance. The dancing and drinking of wine continued throughout the whole night, becoming progressively wilder and more primitive.

Intoxicated by wine (the blood of Bacchus) and by the wild rhythm of the drums and pipes, the Bacchae would gradually reach a state of primitive frenzy in which they would tear living animals to bits and eat their raw flesh. By these acts, the Bacchae were re-enacting the legend of Dionysus. According to legend, Dionysus, the beautiful son of Zeus and Persephone, was torn to pieces by the Titans and eaten, all except for his heart, which was returned to Zeus. Dionysus was then reborn, and the Titans were killed by the thunderbolts of Zeus. From the ashes of the Titans mankind was created, and thus the human race contains not only the evil of the Titans, but also the divinity of Dionysus

The legend of Orpheus contains a parallel to the legend of Dionysos. In grief over his lost wife, Orpheus decides to give up sex forever, and this angers the women of Thrace. As Orpheus sings a last beautiful melody, the women of Thrace tear him to pieces, and his head, still singing, floats down the river Hebrus.

In Orphism, which was a reformed version of the cult of Dionysus, the idea of the simultaneously divine and evil nature of the human race is stressed. Followers of the Orphic religion believed that because of the element of evil and original sin in the human soul, it was doomed to a cycle of death and rebirth. However, the soul could be released from the cycle of reincarnation, and it could regain its divinity and immortality. The methods which the Orphists used to purge the soul included both Bacchic catharsis and asceticism. Also, Orphism included primitive tabus. For example, the followers of the cult were forbidden to eat beans, to touch a white cock, too stir the fire with an iron, to eat from a whole loaf, etc..

Pythagoras, who was a student of Anaximander, became a leader and reformer of the Orphic religion. He was born on the island of Samos, near the Asian mainland, and like other early Ionian philosophers, he is said to have travelled extensively in Egypt and Babylonia. In 529 B.C., he left Samos for Croton, a large Greek colony in southern Italy. When he arrived in Croton, his reputation had preceded him, and a great crowd of people came out of the city to meet him. After Pythagoras had spoken to this crowd, six hundred of them left their homes to join the Pythagorean brotherhood without even saying goodbye to their families.

For a period of about twenty years, the Pythagoreans gained political power in Croton, and they also had political influence in the other Greek colonies of the western Mediterranean. However, when Pythagoras was an old man, the brotherhood which he founded fell from power, their temples at Croton were burned, and Pythagoras himself moved to

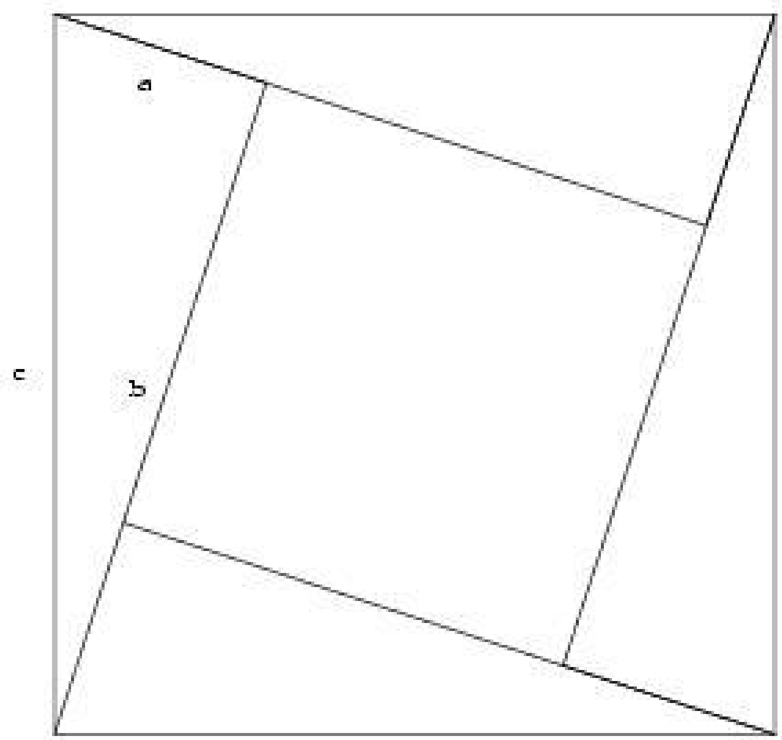

Figure 1.3: **This figure can be used to prove the famous theorem of Pythagoras concerning squares constructed on the sides of a right triangle (i.e. a triangle where two of the sides are perpendicular to each other). It shows a right triangle whose sides, in order of increasing length, are a, b and c. Four identical copies of this triangle, with total area $2ab$, are inscribed inside a square constructed on the long side. The remaining area inside the large square is $(b-a)^2 = a^2 - 2ab + b^2$ and therefore the total area of the large square is $c^2 = a^2 + b^2$.**

Metapontion, another Greek city in southern Italy.

Although it was never again politically influential, the Pythagorean brotherhood survived for more than a hundred years, and the ideas of the Pythagoreans became one of the foundations on which western civilization ultimately was built. Together with Thales, Pythagoras was the founder of western philosophy; and the ideas of Pythagoras have an astonishing breadth and originality which is not found in Thales.

The Pythagorean brotherhood admitted women on equal terms, and all its members held their property in common. Even the scientific discoveries of the brotherhood were considered to have been made in common by all its members.

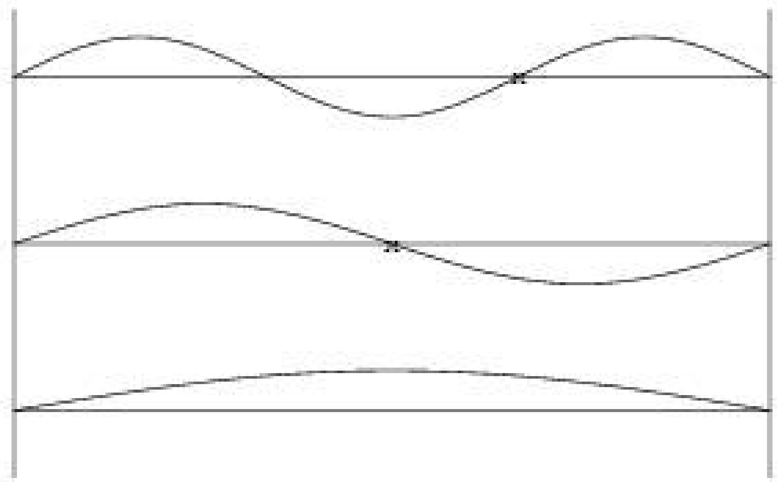

Figure 1.4: **Pythagoras discovered that the musical harmonics that are pleasing to the human ear can be produced by clamping a lyre string of constant tension at points that are related by rational numbers. In the figure the octave and the major fifth above the octave correspond to the ratios 1/2 and 1/3.**

1.5 Pythagorean harmony

The Pythagoreans practiced medicine, and also a form of psychotherapy. According to Aristoxenius, a philosopher who studied under the Pythagoreans, "They used medicine to purge the body, and music to purge the soul". Music was of great importance to the Pythagoreans, as it was also to the original followers of Dionysus and Orpheus.

Both in music and in medicine, the concept of harmony was very important. Here Pythagoras made a remarkable discovery which united music and mathematics. He discovered that the harmonics which are pleasing to the human ear can be produced by dividing a lyre string into lengths which are expressible as simple ratios of whole numbers. For example, if we divide the string in half by clamping it at the center, (keeping the tension constant), the pitch of its note rises by an octave. If the length is reduced to 2/3 of the basic length, then the note is raised from the fundamental tone by the musical interval which we call a major fifth, and so on.

Having discovered that musical harmonics are governed by mathematics, Pythagoras fitted this discovery into the framework of Orphism. According to the Orphic religion, the soul may be reincarnated in a succession of bodies. In a similar way (according to Pythagoras), the "soul" of the music is the mathematical structure of its harmony, and the "body" through which it is expressed is the gross physical instrument. Just as the soul can be reincarnated in many bodies, the mathematical idea of the music can be expressed through many particular instruments; and just as the soul is immortal, the idea of the music exists eternally, although the instruments through which it is expressed may decay.

In distinguishing very clearly between mathematical ideas and their physical expression, Pythagoras was building on the earlier work of Thales, who thought of geometry as dealing with dimensionless points and lines of perfect straightness, rather than with real physical objects. The teachings of Pythagoras and his followers served in turn as an inspiration for Plato's idealistic philosophy.

Pythagoras also extended the idea of harmony to astronomy. He was the first person we know of who recognized that the earth is spherical in shape. He was also the first person to point out that the plane of the orbit of the moon is inclined with respect to the plane of the earth's equator, and the first Greek to recognize that the morning star (Phosphorus) and the evening star (Hesperus) are the same planet. After his time it was called Aphrodite by the Greeks, and later Venus by the Romans.

Pythagoras pointed out that the sun and the planets do not have the same apparent motion as the sphere of the stars. Each has its own motion. This led him to introduce into his cosmology an independently revolving sphere for each of the planets and for the sun. Pythagoras imagined these spheres to be concentric and transparent, and to revolve about the spherical earth.

The idea of spheres carrying the planets was developed further by later Greek astronomers, the greatest of whom was Hipparchus (190 B.C. - 120 B.C.), and it was incorporated into a famous book by Ptolemy (75 B.C. - 10 B.C.). After the fall of Rome, Ptolemy's book, the *Almagest*, survived in the highly civilized Arab world. It was translated into Latin in 1175 A.D., and it dominated astronomical thinking until the Renaissance. Thus the celestial spheres of Anaximander, Pythagoras, Hipparchus and Ptolemy had a long period of influence, and even some calculational usefulness, before they were replaced by the very much better sun-centered cosmology of Copernicus, Tycho Brahe, Kepler, Galileo and Newton.

Pythagoras searched for mathematical harmony in the motions of the planets. He thought that, just as the notes of the musical scale are connected by simple mathematical relationships, so the motions of the planets should obey a simple mathematical law. The Pythagoreans even imagined that as the celestial spheres turned, they produced a kind of cosmic music which only the most highly initiated could hear. The Pythagorean vision of mathematical harmony in the motion of the planets was laughed at by Aristotle, but in the end, after two thousand years, the dream was fulfilled in the laws Newton.

Having found mathematical harmony in the world of sound, and having searched for it in astronomy, Pythagoras tried to find mathematical relationships in the visual world. Among other things, he discovered the five possible regular polyhedra. However, his greatest contribution to geometry is the famous Pythagorean theorem, which is considered to be the most important single theorem in the whole of mathematics.

The Babylonians and the Egyptians knew that for many special right triangles, the sum of the squares formed on the two shorter sides is equal to the square formed on the long side. For example, Egyptian surveyors used a triangle with sides of lengths 3, 4 and 5 units. They knew that between the two shorter sides, a right angle is formed, and that for this particular right triangle, the sum of the squares of the two shorter sides is equal to the square of the longer side. Pythagoras proved that this relationship holds for every right triangle.

In exploring the consequences of his great theorem, Pythagoras and his followers discovered that the square root of 2 is an irrational number. (In other words, it cannot be expressed as the ratio of two integers.) The discovery of irrationals upset them so much that they abandoned algebra. They concentrated entirely on geometry, and for the next two thousand years geometrical ideas dominated science and philosophy.

1.6 The Pythagorean ideal

According to the Pythagoreans, the mind can be out of tune, just as a musical instrument can be out of tune. In medicine and psychiatry, they aimed at achieving harmony in the bodily organs and in the mind. When we speak of "muscle tone" or a "tonic" or "temperance", we are using words which have a Pythagorean origin. The word "philosophy", ("love of wisdom"), was also coined by the Pythagoreans.

In psychiatry, the Pythagoreans used various methods to free the mind from the tyrannical passions and tensions of the body. These methods were graded according to the degree of initiation of the patient. At the lowest level was the catharsis of a Bacchic orgy, followed by a long tranquilizing sleep and then an ascetic regimen to develop self-control. At the highest level of liberation, the mind was drawn away from preoccupation with self by the study of the eternal truths of nature as revealed by mathematics. According to Plutarch, "The function of geometry in Pythagorism is to draw us away from the world of the senses to the world of the intellect and the eternal".

The Orphic religion in some ways resembles the Buddhist and Hindu religions. It is not inconceivable that they have a common origin, since the Greeks were linguistically related to the Indo-European-speaking peoples who conquered India in the first millennium B.C.. In Buddhism, as in Orphism, one aims at release from the wheel of death and rebirth by mastery over self. However, the Pythagorean modification of Orphism introduces an element which is not found in Buddhism. In Pythagorism, the highest level of release and purification is achieved by contemplation of the structure of the universe; and the key to this structure is mathematics.

Pythagoras was the first person to maintain that mathematics is the key to the understanding of nature. In this belief he was completely correct. In the Pythagorean view of nature, mathematical harmony governs the fundamental laws of the universe. In the Pythagorean ethic, the highest vocation is that of the philosopher, and the aim of philosophy is to understand nature through the discovery of the mathematical relationships which govern the universe.

Much of what Pythagoras hoped to achieve in mathematics has been achieved today. For example, quantum theory has shown that the inner structure of an atom is governed by mathematical relationships closely analogous to those governing the harmonics of a lyre string. We have indeed found mathematical harmony in the fundamental laws of nature; but one can ask whether philosophy has brought harmony to human relations, as Pythagoras would have hoped!

We mentioned that the word "philosophy" was invented by the Pythagoreans. The word "theory" in its modern sense is also due to them. The word is derived from the Greek word "thea", meaning "spectacle", (as in the English word "theater"). In Greek, there is a related word, "theorio", meaning "to behold" or "to contemplate". In the Pythagorean ethic, contemplation held the highest place. The Pythagoreans believed that "The greatest purification of all is disinterested science; and it is the man who devotes himself to that, the true philosopher, who has most effectively released himself from the wheel of birth."

One of the Pythagorean mottos was: "A diagram and a step, not a diagram and a penny". Euclid, who belonged to the Pythagorean tradition, once rebuked a student who asked what profit could be gained from a knowledge of geometry. Euclid called a slave and said (pointing at the student): "He wants to profit from geometry. Give him a penny." The student was then dismissed from Euclid's school.

The Greeks of the classical age could afford to ignore practical matters, since their ordinary work was performed for them by slaves. It is unfortunate that the craftsmen and metallurgists of ancient Greece were slaves, while the philosophers were gentlemen who refused to get their hands dirty. An unbridgeable social gap separated the philosophers from the craftsmen; and the empirical knowledge of chemistry and physics, which the craftsmen had gained over the centuries, was never incorporated into Greek philosophy.

The idealism of Pythagoras was further developed and exaggerated by Plato, the most famous student of the Pythagorean school. Plato considered the real world, as revealed by the senses, to be an imperfect expression of the world of ideas; and he thought that philosophers should not concern themselves with the real world.

The factors mentioned above prevented the classical Greeks from making use of observation and induction; and for this reason they were far better in mathematics than in other branches of science. In mathematics, one proceeds by pure deduction from a set of axioms. This insistence on pure deduction gives mathematics its great power and certainty; but in other branches of science, deduction alone is sterile. To be fruitful, deduction must be combined with observation and induction.

The Pythagorean preoccupation with harmony and with ideal proportion was reflected in Greek art. The classical Greeks felt that, just as harmony in music is governed by ideal ratios, so also harmony in architecture and in sculpture is governed by ideal proportions. All Greek temples of the classical period exhibited certain ratios which were considered to be ideal; and Greek sculpture showed, not real individuals, involved in emotions of the moment, but calm ideal figures.

Greek drama did not represent the peculiarities of particular individuals, but rather searched for universal truths concerning human nature. In classical Greek drama, one can even see a reflection of the deductive method which characterized Greek philosophy: In the beginning of a play, the characters are faced with a set of circumstances from which the action inevitably follows, just as the theorems of Euclid inevitably follow from his axioms.

1.7 The golden age of Athens

Between 478 B.C. and 431 B.C. Athens enjoyed a golden age. Their victory in the Persian war gave great prestige to Athens and Sparta, and these two cities became the leaders of the other Greek city states. Athens was the leader of the Delian league, while Sparta was the leader of the Peloponesian League. The Greek world was divided into two blocks, and although Athens and Sparta had been allies during the Persian war, they soon became political and commercial rivals.

Aided by her large navy, Athens pursued a very aggressive commercial policy aimed at monopolistic control of the Mediterranean sea trade. This brought great prosperity to Athens, but it also brought the Delian League into conflict with the Peloponnesian League, a conflict which ultimately led to the downfall of Athens. However, during the period between 478 B.C. and 431 B.C., Athens enjoyed enormous prosperity. Refugees from the Ionian cities on the Asian mainland flocked to Athens, bringing with them their sophisticated culture. These refugees greatly enriched the cultural life of Athens, and their arrival marked the beginning of Athenian intellectual leadership.

The Athenians decided to use the surplus from the treasury of the Delian League to rebuild the Acropolis, which had been destroyed by the Persians. Pericles, the leader of Athens, put his friend, the sculptor Phidias, in charge of the project. The new Acropolis was dominated by the Parthenon, which was built between 447 B.C. and 432 B.C.. Most of the sculptures of the Parthenon were brought to England in the nineteenth century by Lord Elgin, and they are now in the British Museum. The famous "Elgin marbles", together with the ruins of the Parthenon in Athens, symbolize the genius of the age of Pericles.

Wealthy, full of self-confidence, proud of their victory in the Persian war, and proud of their democratic constitution, the Athenians expressed the spirit of their age in sculpture, architecture, drama, poetry and philosophy which shine like beacons across the centuries.

1.8 Anaxagoras

One of the close friends of Pericles was the philosopher Anaxagoras (500 B.C. - 428 B.C.), who came to Athens from Ionia when he was 38 years old. This move by Anaxagoras was important, because it brought to Athens the philosophic tradition of the Ionian cities of Asia Minor. (In a similar way, a century earlier, Pythagoras had carried Ionian philosophy to the Greek colonies of the western Mediterranean.)

Anaxagoras was a rationalist and probably also an atheist (unlike the Pythagoreans). He believed that the stars and planets had been brought into existence by the same forces which formed the earth, and that the laws of nature are the same for celestial bodies as they are for objects on the earth. He thought that the sun and stars were molten rocks, and that the sun was about the same size as the Greek peninsula. (A large meteor which fell on Greece during the lifetime of Anaxagoras may have caused him to form this opinion).

Anaxagoras knew that the moon shines by reflected light, and that there are mountains on the moon. In fact, he believed that the moon is very much like the earth, and he thought that it might possibly be inhabited. He explained correctly the cause of both solar and lunar eclipses, and the phases of the moon.

Even the cultured Athenians found these views a bit too advanced. Anaxagoras was thrown into prison, accused (probably correctly) of atheism. The fact that he was a close

Figure 1.5: **The Parthenon as it looks today.**

friend of Pericles did not help him. The political enemies of Pericles, not daring to attack the great leader directly, chose to embarrass him by attacking his friends.

Pericles used his eloquence to defend Anaxagoras, and he succeeded in having his friend released from prison. However, Anaxagoras felt that it was not safe to remain in Athens. In 434 B.C. he retired to the little town of Lampsacus on the Hellespont, where he spent the remainder of his life.

1.9 The atomists

In the 5th century B.C. there was a great deal of discussion among the Greek philosophers about whether there is anything permanent in the universe. Heraclitus (540 B.C. - 475 B.C.) maintained that *everything* is in a state of flux. Parmenides (540 B.C. - c. 470 B.C.) maintained that on the contrary *nothing* changes - that all change is illusory. Leucippus (490 B.C. - c. 420 B.C.) and his student Democritus (470 B.C. - c. 380 B.C.), by a lucky chance, hit on what a modern scientist would regard as very nearly the correct answer.

According to Democritus, if we cut an apple in half, and then cut the half into parts, and keep on in this way for long enough, we will eventually come down to pieces which cannot be further subdivided. Democritus called these ultimate building blocks of matter "atoms", which means "indivisible". He visualized the spaces between the atoms as being empty, and he thought that when a knife cuts an apple, the sharp edge of the blade fits into the empty spaces between the atoms and forces them apart.

Democritus believed that each atom is unchanged in the processes which we observe with our senses, where matter seems to change its form. However, he believed that the atoms are in a state of constant motion, and that they can combine with each other in various ways, thus producing the physical and chemical changes which we observe in nature. In other words, each atom is in itself eternal, but the way in which the atoms combine with each other is in a state of constant flux because of the motion of the atoms.

This is very nearly the same answer which we would give today to the question of which things in the universe are permanent and which change. Of course, the objects which we call "atoms" *can* be further subdivided, but if Democritus were living today he would say that we have merely made the mistake of calling the wrong things "atoms". We should really apply the word to fundamental particles such as quarks, which cannot be further subdivided.

In discussing which things in the universe are permanent and which change, we would also add, from our modern point of view, that the fundamental laws of the universe are permanent. In following these unchanging laws, matter and energy constantly alter their configuration, but the basic laws of nature remain invariant. For example, the configuration of the planets changes constantly, but these constant changes are governed by Newton's laws of motion, which are eternal.

Of the various ancient philosophers, Democritus is the one who comes closest to our modern viewpoint. However, the ideas of Democritus, like those of Anaxagoras, were too advanced for his contemporaries. Although Democritus was not actually thrown into prison for his beliefs, they aroused considerable hostility. According to Diogenes Laertius, Plato dislike the ideas of Democritus so much that he wished that all of his books could be burned. (Plato had his wish! None of the seventy-two books of Democritus has survived.) Aristotle also argued against atomism, and because of the enormous authority which was attached to Aristotle's opinions, atomism almost disappeared from western thought until the time of John Dalton (1766 - 1844).

That the ideas of Democritus did not disappear entirely was due to the influence of Epicurus (341 B.C. - 270 B.C.), who made mechanism and atomism the cornerstones of his philosophy. The Roman poet Lucretius (95 B.C. - 55 B.C.) expounded the philosophy of Epicurus in a long poem called *De Natura Rerum* (On the Nature of Things). During the middle ages, this poem disappeared completely, but in 1417, a single surviving manuscript was discovered. The poem was then published, using Gutenberg's newly-invented printing press, and it became extremely popular. Thus, the idea of atoms was not entirely lost, and after being revived by John Dalton, it became one of the cornerstones of modern science.

Figure 1.6: **A painting depicting Democritus. He was sometimes called "the laughing philosopher" because of his belief in a cheerful attitude towards life.**

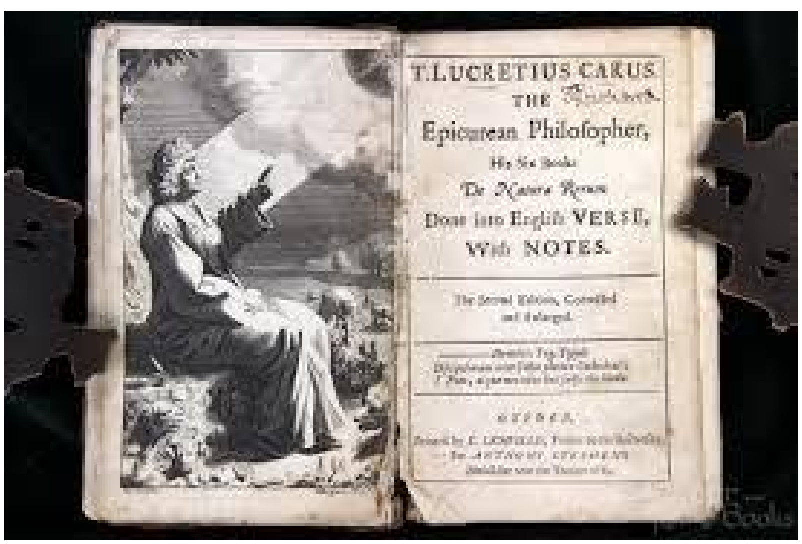

Figure 1.7: **An English translation of *De Natura Rerum*.**

1.10 Hippocrates

The physician Hippocrates was born in about 460 B.C. on the island of Kos. According to tradition, he visited Egypt during the early part of his life. There he studied medicine, especially the medical works of Imhotep. He is also said to have studied under Democritus. Returning to the island of Kos, he founded the most rational school of medicine of the ancient world. He had many students, among whom were his sons and his sons-in law. During the later part of his life, he also taught and practiced in Thrace and Athens.

The medical school founded by Hippocrates was famous for its rationality and for its high ethical standard. The medical ethics of Hippocrates live on today in the oath taken by physicians. The rationality of Hippocrates is evident in all the writings of his school. For example, a book on epilepsy, called *The Sacred Disease*, contains the following passage:

"As for this disease called divine, surely it has its nature and causes, as have other diseases. It arises, like them, from things which enter and leave the body... Such things are divine or not - as you will, for the distinction matters not, and there is no need to make such a division anywhere in nature; for all alike are divine, or all are natural. All have their antecedent causes, which can be found by those who seek them."

More than fifty books of Hippocrates' school were collected in Alexandria in the 3rd century B.C.. All of them were attributed by the Alexandrians to Hippocrates himself, but undoubtedly many of the books were written by his students. The physicians of the school of Hippocrates believed that cleanliness and rest are important for a sick or wounded patient, and that the physician should interfere as little as possible with the natural healing processes of the body. The books of the school contain much careful observation of disease. Hippocrates and his school resisted the temptation to theorize without a basis of carefully observed facts, just as they also resisted the temptation to introduce supernatural causes into medicine.

Hippocrates is said to have died in his hundredth year. According to tradition, he was humane, observant, learned, orderly and calm, with a grave and thoughtful attitude, a complete mastery of his own passions and a profound sympathy for the sufferings of his patients. We feel his influence today, both as one of the great founders of rational medicine, and as a pioneer of observation and inductive reasoning in science.

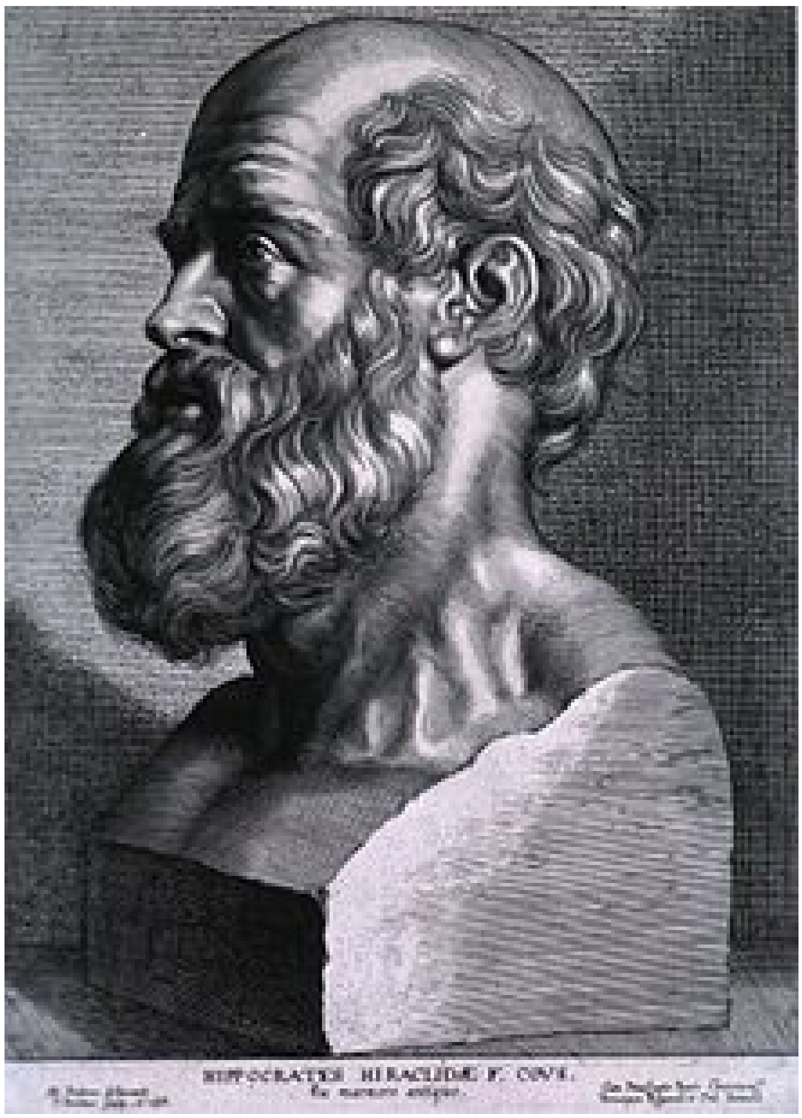

Figure 1.8: **A bust of Hippocrates, engraved by Peter Paul Rubens in 1638.**

1.11 The Sophists and Socrates

Since Athens was a democracy, the citizens often found themselves speaking at public meetings.Eloquence could be turned into influence, and the wealthy Athenians imported teachers to help them master the art of rhetoric. These teachers, called "Sophists" (literally "wisdomists"), besides teaching rhetoric, also taught a form of philosophy which denied the existence of absolute truth, absolute beauty and absolute justice. According to the Sophists, "man is the measure of all things", all truths are relative, "beauty is in the eye of the beholder", and justice is not divine or absolute but is a human institution.

Opposed to the Sophists was the philosopher Socrates, who believed passionately in the existence of the absolutes which the Sophists denied. According to Socrates, a beautiful object would be beautiful whether or not there were any humans to observe it. Socrates adopted from the Sophists a method of conducting arguments by asking questions which made people see for themselves the things which Socrates wanted them to see.

The Sophists talked about moral and political questions, rather than about the nature of the universe. Socrates was an opponent of the Sophists, but like them he also neglected the study of nature and concentrated on the moral and political problems of man, "the measure of all things".The Sophists, together with Socrates and his pupil Plato, exerted a great influence in causing a split between moral philosophy and natural philosophy.

The beginning of the end of classical Greek civilization came in 431 B.C., when Athens, pushing her aggressive commercial policy to an extreme, began to expel Corinthian merchants from markets around the Aegean. Corinth reacted by persuading the Peloponesian League to declare war on Athens. This was the beginning of a long war which ruined Greece.

Realizing that they could not resist the Spartan land forces, the Athenians abandoned the farmland outside their city, and took refuge inside the walls. The Athenians continued their prosperous foreign trade, and they fed their population with grain imported from the east. Ships bringing grain also brought the plague. A large part of the population of Athens died of the plague, including the city's great leader, Pericles. No leader of equal stature was found to replace him, and the democratic Athenian government degenerated into mob rule.

In 404 B.C., when the fleet of Athens was destroyed in a disastrous battle, the city surrendered to the Spartans. However, the Spartans remembered that without Athens, they would be unable to resist the Persian Empire. Therefore they did not destroy Athens totally, but were content to destroy the walls of Athens, reducing the city to the status of a satellite of Sparta.

Looking for scapegoats on whom to blame this disaster, the Athenian mobs seized Socrates (one of the few intellectuals who remained alive after the Peloponesian War), and they condemned him to death for failing to believe in the gods of the city.

For a short period, Sparta dominated the Greek world; but soon war broke out again, and the political scene degenerated into a chaos of wars between the city states.

Figure 1.9: **The Death of Socrates, by Jacques-Louis David (1787).**

1.12 Plato

Darkness was falling on the classical Greek world, but the light of civilization had not quite gone out. Socrates was dead, but Plato, the student of Socrates, kept his memory alive by writing dialogues in which Socrates appeared as a character.

Plato (427 B.C. - 317 B.C.) was an Athenian aristocrat, descended from the early kings of Athens. His real name was Aristocles, but he was called by his nickname, Platon (meaning "broad") because of his broad shoulders. After the death of Socrates, Plato left Athens, saying that the troubles of the city would never end until a philosopher became king. (He may have had himself in mind!) He travelled to Italy and studied under the Pythagoreans. In 387 he returned to Athens and founded a school, which was called the Academy because it stood on ground which had once belonged to a Greek named Academus.

Plato developed a philosophy which was based on the idealism of the Pythagoreans. In Pythagorean philosophy, a clear distinction was made between mathematical ideas and their physical expression. For example, geometry was considered to deal, not with real physical objects, but with idealized figures, constructed from lines of perfect straightness and infinite thinness. Plato developed and exaggerated the idealism of Pythagoras. In Plato's philosophy, the real world is corruptible and base, but the world of ideas is divine and eternal. A real table, for example, is an imperfect expression of the idea of a table. Therefore we ought to turn our eyes away from the real world and live in the world of ideas.

Plato's philosophy was just what the Athenians wanted! All around them, their world

Figure 1.10: **Plato and Aristotle by Raphael.**

was crumbling. They gladly turned their backs on the unpleasantness of the real world, and accepted Plato's invitation to live in the world of ideas, where nothing decays and where the golden laws of mathematics rule eternally.

By all accounts, Plato was an excellent mathematician, and through his influence mathematics obtained a permanent place in education.

1.13 Aristotle

Plato's favorite student was a young man from Macedon named Aristotle. Plato called him "the intelligence of the school". He was born in 381 B.C., the son of the court physician of the king of Macedon, and at the age of seventeen he went to Athens to study. He joined Plato's Academy and worked there for twenty years until Plato died. Aristotle then left the Academy, saying that he disapproved of the emphasis on mathematics and theory and the decline of natural science.

Aristotle traveled throughout the Greek world and married the sister of the ruler of one of the cities which he visited. In 312 B.C., Philip II, who had just become king of Macedon, sent for Aristotle and asked him to become the tutor of his fourteen-year-old son, Alexander. Aristotle accepted this post and continued in it for a number of years. During this period, the Macedonians, under Philip, conquered most of the Greek city-states. Philip then planned to lead a joint Macedonian and Greek force in an attack on the Persian Empire. However, in 336 B.C., before he could begin his invasion of Persia, he was murdered (probably by an agent of his wife, Olympia, who was jealous because Philip had taken a second wife). Alexander then succeeded to his father's throne, and, at the head of the Macedonian and Greek army, he invaded Persia.

Aristotle, no longer needed as a royal tutor, returned to Athens and founded a school of his own called the Lyceum. At the Lyceum he built up a collection of manuscripts which resembled the library of a modern university.

Aristotle was a very great organizer of knowledge, and his writings almost form a one-man encyclopedia. His best work was in biology, where he studied and classified more than five hundred animal species, many of which he also dissected. In Aristotle's classification of living things, he shows an awareness of the interrelatedness of species. This interrelatedness was later brought forward by Darwin as evidence for the theory of evolution. One cannot really say that Aristotle proposed a theory of evolution, but he was groping towards the idea. In his history of animals, he writes:

"Nature proceeds little by little from lifeless things to animal life, so that it is impossible to determine either the exact line of demarcation, or on which side of the line an intermediate form should lie. Thus, next after lifeless things in the upward scale comes the plant. Of plants, one will differ from another as to its apparent amount of vitality. In a word, the whole plant kingdom, whilst devoid of life as compared with the animal, is yet endowed with life as compared with other corporeal entities. Indeed, there is observed in plants a continuous scale of ascent towards the animal."

Aristotle's classification of living things, starting at the bottom of the scale and going upward, is as follows: Inanimate matter, lower plants and sponges, higher plants, jellyfish, zoophytes and ascidians, molluscs, insects, jointed shellfish, octopuses and squids, fish and reptiles, whales, land mammals and man. The acuteness of Aristotle's observation and analysis can be seen from the fact that he classified whales and dolphins as mammals (where they belong) rather than as fish (where they superficially seem to belong).

One of Aristotle's important biological studies was his embryological investigation of the developing chick. Ever since his time, the chick has been the classical object for embryological studies. He also studied the four-chambered stomach of the ruminants and the detailed anatomy of the mammalian reproductive system. He used diagrams to illustrate complex anatomical relationships - an important innovation in teaching technique.

Aristotle's physics and astronomy were far less successful than his biology. In these fields, he did not contribute with his own observations. On the whole, he merely repeated the often-mistaken ideas of his teacher, Plato. In his book *On The Heavens*, Aristotle writes:

"As the ancients attributed heaven and the space above it to the gods, so our reasoning shows that it is incorruptible and uncreated and untouched by mortal troubles. No force is needed to keep the heaven moving, or to prevent it from moving in another manner. Nor need we suppose that its stability depends on its support by a certain giant, Atlas, as in the ancient fable; as though all bodies on high possessed gravity and an earthly nature. Not so has it been preserved for so long, nor yet, as Empedocles asserts, by whirling around faster than its natural motion downward."

Empedocles (490 B.C. - 430 B.C.) was a Pythagorean philosopher who studied, among other things, centrifugal forces. For example, he experimented with buckets of water which he whirled about his head, and he knew that the water does not run out. The passage which we have just quoted shows that Empedocles had suggested the correct explanation for the stability of the moon's orbit. The moon is constantly falling towards the earth, but at the same time it is moving rapidly in a direction perpendicular to the line connecting it with the earth. The combination of the two motions gives the moon's orbit its nearly-circular shape.

Empedocles had thus hit on the germ of the idea which Newton later developed into his great theory of universal gravitation and planetary motion. In the above passage, however, Aristotle rejects the hypothesis of Empedocles. He asserts instead that the heavens are essentially different from the earth, and not subject to the same laws.

Aristotle believed celestial bodies to be composed of a fifth element - ether. This, he thought, was why the heavens were not subject to the laws which apply to earthly matter. He thought that for earthly bodies, the natural motion was a straight line, but for celestial bodies the natural motion was circular because "one kind of motion is divine and immortal, having no end, but being in itself the end of other motions"; and motion in a circle is "perfect, having no beginning or end, nor ceasing in infinite time."

This doctrine, that the motion of celestial bodies must be uniform and circular, was a legacy from Plato. In fact, Plato had placed before his Academy the problem of reconciling the apparently irregular motion of the planets with the uniform circular motion which Plato believed they *had* to have. In a famous phrase, Plato said that the problem was to "save the appearances".

The problem of "saving the appearances" was solved in a certain approximation by Eudoxis, one of Plato's students. He imagined a system of concentric spheres, attached to one another by axes. In this picture, each sphere rotates uniformly about its own axis, but since the spheres are attached to each other in a complex way, the resulting motion duplicates the complex apparent motion of the planets.

Aristotle accepted the system of Eudoxis, and even added a few more spheres of his own to make the system more accurate. In making a distinction between the heavens and the earth, Aristotle gave still another answer to the question of which things in the universe change and which are permanent: According to Aristotle, the region beneath the sphere of the moon is corrupt and changeable, but above that sphere, everything is eternal and divine. Change is bad, permanence is good - that is the emotional content of the teaching of Plato and Aristotle, the two great philosophers of the rapidly-decaying 4th century B.C.

Greek civilization.

Besides writing on biology, physics and astronomy, Aristotle also discussed ethics, politics and literary criticism, and he made a great contribution to western thought by inventing a formal theory of logic. His writings on logic were made popular by St. Thomas Aquinas (1225-1274), and during the period between Aquinas and the Renaissance, Aristotle's logic dominated theology and philosophy. In fact, through his work on logic, Aristotle became so important to scholastic philosophy that his opinions on other subjects were accepted as absolute authority. Unfortunately, Aristotle's magnificent work in biology was forgotten, and it was his misguided writings on physics and astronomy which were influential. Thus, for the experimental scientists of the 16th and 17th centuries, Aristotle eventually became the symbol of wrongness, and many of their struggles and victories have to do with the overthrow of Aristotle's doctrines.

Even after it had lost every vestige of political power, Athens continued to be a university town, like Oxford or Cambridge. Plato's Academy continued to teach students for almost a thousand years. It was finally closed in 529 A.D. by the Emperor Justinian, who feared its influence as a stronghold of "pagan philosophy".

Aristotle's Lyceum continued for some time as an active institution, but it soon declined, because although Athens remained a center of moral philosophy, the center of scientific activity had shifted to Alexandria. The collection of manuscripts which Aristotle had built up at the Lyceum became the nucleus of the great library at Alexandria.

The books of Plato and Aristotle survived better than the books of other ancient philosophers, perhaps because Plato and Aristotle founded schools. Plato's authenticated dialogues form a book as long as the Bible, covering all fields of knowledge. Aristotle's lectures were collected into 150 volumes. (Of course, each individual volume was not as long as a modern printed book.) Of these, 50 have survived. Some of them were found in a pit in Asia Minor by soldiers of the Roman general Sulla in 80 A.D., and they were brought to Rome to be recopied.

Some of the works of Aristotle were lost in the West, but survived during the dark ages in Arabic translations. In the 12th and 13th centuries, these works were translated into Latin by European scholars who were in contact with the Arab civilization. Through these translations, Europe enthusiastically rediscovered Aristotle, and until the 17th century, he replaced Plato as *the* philosopher.

The influence of Plato and Aristotle was very great (perhaps greater than they deserved), because of their literary skill, because so many of their books survived, because of the schools which they founded, and because Plato and Aristotle wrote about all of knowledge and wrapped it up so neatly that they seemed to have said the last word.

Suggestions for further reading

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6. E.T. Bell, *Men of Mathematics*, Simon and Schuster, New York (1937).
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Chapter 2

THE MUSEUM AND THE GREAT LIBRARY OF ALEXANDRIA

2.1 Alexander of Macedon

How much influence did Aristotle have on his pupil, Alexander of Macedon? We know that in 327 B.C. Alexander, (who was showing symptoms of megalomania), executed Aristotle's nephew, Callisthenes; so Aristotle's influence cannot have been very complete. On the other hand, we can think of Alexander driving his reluctant army beyond the Caspian Sea to Parthia, beyond Parthia to Bactria, beyond Bactria to the great wall of the Himalayas, and from there south to the Indus, where he turned back only because of the rebellion of his homesick officers. This attempt to reach the uttermost limits of the world seems to have been motivated as much by a lust for knowledge as by a lust for power.

Alexander was not a Greek, but nevertheless he regarded himself as an apostle of Greek culture. As the Athenian orator, Isocrates, remarked, "The word 'Greek' is not so much a term of birth as of mentality, and is applied to a common culture rather than to a common descent."

Although he was cruel and wildly temperamental, Alexander could also display an almost hypnotic charm, and this charm was a large factor in his success. He tried to please the people of the countries through which he passed by adopting some of their customs. He married two barbarian princesses, and, to the dismay of his Macedonian officers, he also adopted the crown and robes of a Persian monarch.

Wherever Alexander went, he founded Greek-style cities, many of which were named Alexandria. In Babylon, In 323 B.C., after a drunken orgy, Alexander caught a fever and died at the age of 33. His loosely-constructed empire immediately fell to pieces. The three largest pieces were seized by three of his generals. The Persian Empire went to Seleucis, and became known as the Seleucid Empire. Antigonius became king of Macedon and protector of the Greek city-states. A third general, Ptolemy, took Egypt.

Although Alexander's dream of a politically united world collapsed immediately after his death, his tour through almost the entire known world had the effect of blending the

Figure 2.1: **Bust of a young Alexander the Great from the Hellenistic era, British Museum.**

ancient cultures of Greece, Persia, India and Egypt, and producing a world culture. The era associated with this culture is usually called the Hellenistic Era (323 B.C. - 146 B.C.). Although the Hellenistic culture was a mixture of all the great cultures of the ancient world, it had a decidedly Greek flavor, and during this period the language of educated people throughout the known world was Greek.

2.2 Alexandria

Nowhere was the cosmopolitan character of the Hellenistic Era more apparent than at Alexandria in Egypt. No city in history has ever boasted a greater variety of people. Ideally located at the crossroads of world trading routes, Alexandria became the capital of the world - not the political capital, but the cultural and intellectual capital.

Miletus in its prime had a population of 25,000; Athens in the age of Pericles had about 100,000 people; but Alexandria was the first city in history to reach a population of over a million!

Strangers arriving in Alexandria were impressed by the marvels of the city - machines which sprinkled holy water automatically when a five-drachma coin was inserted, water-driven organs, guns powered by compressed air, and even moving statues, powered by water or steam!

For scholars, the chief marvels of Alexandria were the great library and the Museum established by Ptolemy I. Credit for making Alexandria the intellectual capital of the world must go to Ptolemy I and his successors (all of whom were named Ptolemy except the last of the line, the famous queen, Cleopatra). Realizing the importance of the schools which had been founded by Pythagoras, Plato and Aristotle, Ptolemy I established a school at Alexandria. This school was called the Museum, because it was dedicated to the muses.

Near to the Museum, Ptolemy built a great library for the preservation of important manuscripts. The collection of manuscripts which Aristotle had built up at the Lyceum in Athens became the nucleus of this great library. The library at Alexandria was open to the general public, and at its height it was said to contain 750,000 volumes. Besides preserving important manuscripts, the library became a center for copying and distributing books.

The material which the Alexandrian scribes used for making books was papyrus, which was relatively inexpensive. The Ptolemys were anxious that Egypt should keep its near-monopoly on book production, and they refused to permit the export of papyrus. Pergamum, a rival Hellenistic city in Asia Minor, also boasted a library, second in size only to the great library at Alexandria. The scribes at Pergamum, unable to obtain papyrus from Egypt, tried to improve the preparation of the skins traditionally used for writing in Asia. The resulting material was called *membranum pergamentum*, and in English, this name has become “parchment”.

2.3 Euclid

One of the first scholars to be called to the newly-established Museum was Euclid. He was born in 325 B.C. and was probably educated at Plato's Academy in Athens. While in Alexandria, Euclid wrote the most successful text-book of all time, the *Elements of Geometry*. The theorems in this splendid book were not, for the most part, originated by Euclid. They were the work of many generations of classical Greek geometers. Euclid's contribution was to take the theorems of the classical period and to arrange them in an order which is so logical and elegant that it almost defies improvement. One of Euclid's great merits is that he reduces the number of axioms to a minimum, and he does not conceal the dubiousness of certain axioms.

Euclid's axiom concerning parallel lines has an interesting history: This axiom states that "Through a given point not on a given line, one and only one line can be drawn parallel to a given line". At first, mathematicians doubted that it was necessary to have such an axiom. They suspected that it could be proved by means of Euclid's other more simple axioms. After much thought, however, they decided that the axiom is indeed one of the necessary foundations of classical geometry. They then began to wonder whether there could be another kind of geometry where the postulate concerning parallels is discarded. These ideas were developed in the 18th and 19th centuries by Lobachevsky, Bolyai, Gauss and Riemann, and in the 20th century by Levi-Civita. In 1915, the mathematical theory of non-Euclidean geometry finally became the basis for Einstein's general theory of relativity.

Besides classical geometry, Euclid's book also contains some topics in number theory. For example, he discusses irrational numbers, and he proves that the number of primes is infinite. He also discusses geometrical optics.

Euclid's *Elements* has gone through more than 1,000 editions since the invention of printing - more than any other book, with the exception of the Bible. Its influence has been immense. For more than two thousand years, Euclid's *Elements of Geometry* has served as a model for rational thought.

Figure 2.2: **19th-century statue of Euclid by Joseph Durham in the Oxford University Museum of Natural History.**

2.4 Eratosthenes

Eratosthenes (276 B.C. - 196 B.C.), the director of the library at Alexandria, was probably the most cultured man of the Hellenistic Era. His interests and abilities were universal. He was an excellent historian, in fact the first historian who ever attempted to set up an accurate chronology of events. He was also a literary critic, and he wrote a treatise on Greek comedy. He made many contributions to mathematics, including a study of prime numbers and a method for generating primes called the "sieve of Eratosthenes".

As a geographer, Eratosthenes made a map of the world which, at that time, was the most accurate that had ever been made. The positions of various places on Eratosthenes' map were calculated from astronomical observations. The latitude was calculated by measuring the angle of the polar star above the horizon, while the longitude probably was calculated from the apparent local time of lunar eclipses.

As an astronomer, Eratosthenes made an extremely accurate measurement of the angle between the axis of the earth and the plane of the sun's apparent motion; and he also prepared a map of the sky which included the positions of 675 stars.

Eratosthenes' greatest achievement however, was an astonishingly precise measurement of the radius of the earth. The value which he gave for the radius was within 50 miles of what we now consider to be the correct value! To make this remarkable measurement, Eratosthenes of course assumed that the earth is spherical, and he also assumed that the sun is so far away from the earth that rays of light from the sun, falling on the earth, are almost parallel. He knew that directly south of Alexandria there was a city called Syene, where at noon on a midsummer day, the sun stands straight overhead. Given these facts, all he had to do to find the radius of the earth was to measure the distance between Alexandria and Syene. Then, at noon on a midsummer day, he measured the angle which the sun makes with the vertical at Alexandria. From these two values, he calculated the circumference of the earth to be a little over 25,000 miles. This was so much larger than the size of the known world that Eratosthenes concluded (correctly) that most of the earth's surface must be covered with water; and he stated that "If it were not for the vast extent of the Atlantic, one might sail from Spain to India along the same parallel."

Eratosthenes' friends (one of them was Archimedes) joked with him about his dilettantism. They claimed that he was spreading his talents too thinly, and they gave him the nickname, "Beta", meaning that in all the fields in which he chose to exert himself, Eratosthenes was the second best in the world, rather than the best. This was unjust: In geography, Eratosthenes was unquestionably "Alpha"!

Eratosthenes' brilliant work in geography illustrates a difference between classical Greek science and Hellenistic science. In the classical Greek world, philosophers were far removed from everyday affairs. However, in busy, commercial Alexandria, men like Eratosthenes were in close contact with practical problems, such as the problems of navigation, metallurgy and engineering. This close contact with practical problems gave Hellenistic science a healthy realism which was lacking in the overly-theoretical science of classical Greece.

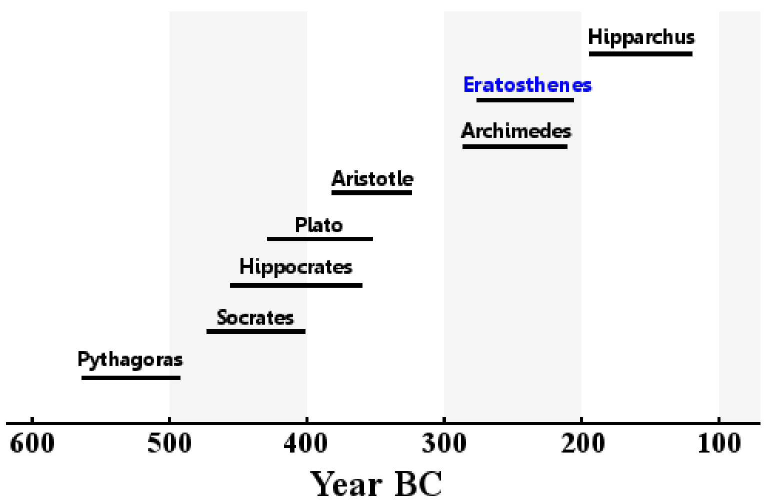

Figure 2.3: **We see plotted here the lifespans of some of the major figures of the classical Greek and Hellenistic eras. Eratosthenes was a contemporary of Archimedes.**

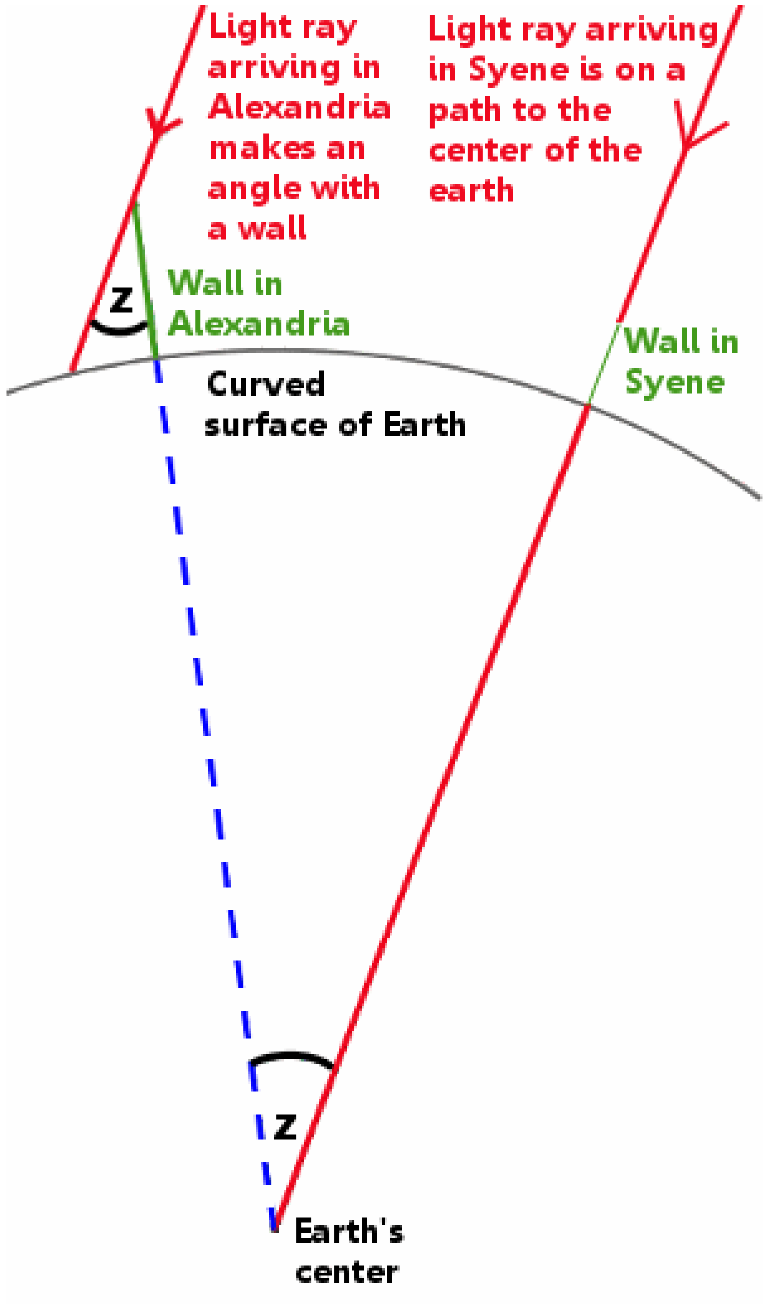

Figure 2.4: **This figure shows the principle behind Eratosthenes' measurement of the radius of the earth.**

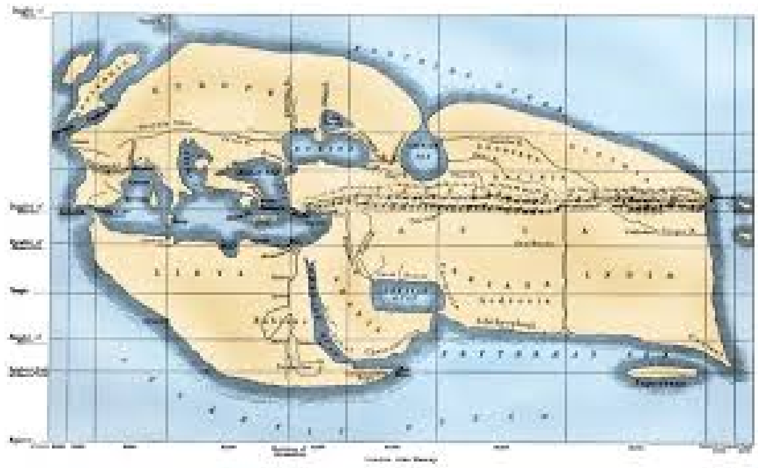

Figure 2.5: **Eratosthenes' map of the known world. The Mediterranean region, the Red Sea, and the Black Sea are quite accurately depicted. We can also see Britain and Ireland as well as the Persian Gulf. From the small size of the known world, compared with the total surface of the earth, Eratosthenes correctly concluded that most of the earth's surface is covered with water.**

2.5 Aristarchus

The Hellenistic astronomers not only measured the size of the earth - they also measured the sizes of the sun and the moon, and their distances from the earth. Among the astronomers who worked on this problem was Aristarchus (c. 320 B.C. - c. 250 B.C.). Like Pythagoras, he was born on the island of Samos, and he may have studied in Athens under Strato. However, he was soon drawn to Alexandria, where the most exciting scientific work of the time was being done.

Aristarchus calculated the size of the moon by noticing the shape of the shadow of the earth thrown on the face of the moon during a solar eclipse. From the shape of the earth's shadow, he concluded that the diameter of the moon is about a third the diameter of the earth. (This is approximately correct).

From the diameter of the moon and the angle between its opposite edges when it is seen from the earth, Aristarchus could calculate the distance of the moon from the earth. Next he compared the distance from the earth to the moon with the distance from the earth to the sun. To do this, he waited for a moment when the moon was exactly half-illuminated. Then the earth, moon and sun formed a right triangle, with the moon at the corner corresponding to the right angle. Aristarchus, standing on the earth, could measure the angle between the moon and the sun. He already knew the distance from the earth to the moon, so now he knew two angles and one side of the right triangle. This was enough to allow him to calculate the other sides, one of which was the sun-earth distance. His value for this distance was not very accurate, because small errors in measuring the angles were magnified in the calculation.

Aristarchus concluded that the sun is about twenty times as distant from the earth as the moon, whereas in fact it is about four hundred times as distant. Still, even the underestimated distance which Aristarchus found convinced him that the sun is enormous! He calculated that the sun has about seven times the diameter of the earth, and three hundred and fifty times the earth's volume. Actually, the sun's diameter is more than a hundred times the diameter of the earth, and its volume exceeds the earth's volume by a factor of more than a million!

Even his underestimated value for the size of the sun was enough to convince Aristarchus that the sun does not move around the earth. It seemed ridiculous to him to imagine the enormous sun circulating in an orbit around the tiny earth. Therefore he proposed a model of the solar system in which the earth and all the planets move in orbits around the sun, which remains motionless at the center; and he proposed the idea that the earth spins about its axis once every day.

Although it was the tremendous size of the sun which suggested this model to Aristarchus, he soon realized that the heliocentric model had many calculational advantages: For example, it made the occasional retrograde motion of certain planets much easier to explain. Unfortunately, he did not work out detailed table for predicting the positions of the planets. If he had done so, the advantages of the heliocentric model would have been so obvious that it might have been universally adopted almost two thousand years before the time of Copernicus, and the history of science might have been very different.

Aristarchus was not the first person to suggest that the earth moves in an orbit like the other planets. The Pythagorean philosophers, especially Philolaus (c. 480 B.C. - c. 420 B.C.), had also suggested a moving earth. However, the Pythagorean model of the solar system was marred by errors, while the model proposed by Aristarchus was right in every detail.

Aristarchus was completely right, but being right does not always lead to popularity. His views were not accepted by the majority of astronomers, and he was accused of impiety by the philosopher Cleanthes, who urged the authorities to make Aristarchus suffer for his heresy. Fortunately, the age was tolerant and enlightened, and Aristarchus was never brought to trial.

The model of the solar system on which the Hellenistic astronomers finally agreed was not that of Aristarchus but an alternative (and inferior) model developed by Hipparchus (c. 190 B.C. - c. 120 B.C.). Hipparchus made many great contributions to astronomy and mathematics. For example, he was the first person to calculate and publish tables of trigonometric functions. He also invented many instruments for accurate naked-eye observations. He discovered the "precession of equinoxes", introduced a classification of stars according to their apparent brightness, and made a star-map which far outclassed the earlier star-map of Eratosthenes. Finally, he introduced a model of the solar system which allowed fairly accurate calculation of the future positions of the planets, the sun and the moon.

In English, we use the phrase "wheels within wheels" to describe something excessively complicated. This phrase is derived from the model of the solar system introduced by Hipparchus! In his system, each planet has a large wheel which revolves with uniform speed about the earth (or in some cases, about a point near to the earth). Into this large wheel was set a smaller wheel, called the "epicycle", which also revolved with uniform speed. A point on the smaller wheel was then supposed to duplicate the motion of the planet. In some cases, the model of Hipparchus needed still more "wheels within wheels" to duplicate the planet's motion.. The velocities and sizes of the wheels were chosen in such a way as to "save the appearances".

The model of Hipparchus was popularized by the famous Egyptian astronomer, Claudius Ptolemy (c. 75 A.D. - c. 135 A.D.), in a book which dominated astronomy up to the time of Copernicus. Ptolemy's book was referred to by its admirers as *Megale Mathematike Syntaxis* (The Great Mathematical Composition). During the dark ages which followed the fall of Rome, Ptolemy's book was preserved and translated into Arabic by the civilized Moslems, and its name was shortened to *Almagest* (The Greatest). It held the field until, in the 15th century, the brilliant heliocentric model of Aristarchus was rescued from oblivion by Copernicus.

2.6 Archimedes

Archimedes was the greatest mathematician of the Hellenistic Era. In fact, together with Newton and Gauss, he is considered to be one of the greatest mathematicians of all time.

Archimedes was born in Syracuse in Sicily in 287 B.C.. He was the son of an astronomer, and he was also a close relative of Hieron II, the king of Syracuse. Like most scientists of his time, Archimedes was educated at the Museum in Alexandria, but unlike most, he did not stay in Alexandria. He returned to Syracuse, probably because of his kinship with Hieron II. Being a wealthy aristocrat, Archimedes had no need for the patronage of the Ptolemys.

Many stories are told about Archimedes: For example, he is supposed to have been so absent-minded that he often could not remember whether he had eaten. Another (perhaps apocryphal) story has to do with the discovery of "Archimedes Principle" in hydrostatics. According to the story, Hieron had purchased a golden crown of complex shape, and he had begun to suspect that the goldsmith had cheated him by mixing silver with gold. Since Hieron knew that his bright relative, Archimedes, was an expert in calculating the volumes of complex shapes, he took the crown to Archimedes and asked him to determine whether it was made of pure gold (by calculating its specific gravity). However, the crown was too irregularly shaped, and even Archimedes could not calculate its volume.

While he was sitting in his bath worrying about this problem, Archimedes reflected on the fact that his body seemed less heavy when it was in the water. Suddenly, in a flash of intuition, he saw that the amount by which his weight was reduced was equal to the weight of the displaced water. He leaped out of his bath shouting *"Eureka! Eureka!"* ("I've found it!") and ran stark naked through the streets of Syracuse to the palace of Hieron to tell him of the discovery.

The story of Hieron's crown illustrates the difference between the Hellenistic period and the classical period. In the classical period, geometry was a branch of religion and philosophy. For aesthetic reasons, the tools which a classical geometer was allowed too use were restricted to a compass and a straight-edge. Within these restrictions, many problems are insoluble. For example, within the restrictions of classical geometry, it is impossible to solve the problem of trisecting an angle. In the story of Hieron's crown, Archimedes breaks free from the classical restrictions and shows himself willing to use every conceivable means to achieve his purpose.

One is reminded of Alexander of Macedon who, when confronted with the Gordian Knot, is supposed to have drawn his sword and cut the knot in two! In a book *On Method*, which he sent to his friend Eratosthenes, Archimedes even confesses to cutting out figures from paper and weighing them as a means of obtaining intuition about areas and centers of gravity. Of course, having done this, he then derived the areas and centers of gravity by more rigorous methods.

One of Archimedes' great contributions to mathematics was his development of methods for finding the areas of plane figures bounded by curves, as well as methods for finding the areas and volumes of solid figures bounded by curved surfaces. To do this, he employed the "doctrine of limits". For example, to find the area of a circle, he began by inscribing a square inside the circle. The area of the square was a first approximation to the area of the circle. Next, he inscribed a regular octagon and calculated its area, which was a closer approximation to the area of the circle. This was followed by a figure with 16 sides, and then 32 sides, and so on. Each increase in the number of sides brought him closer to the

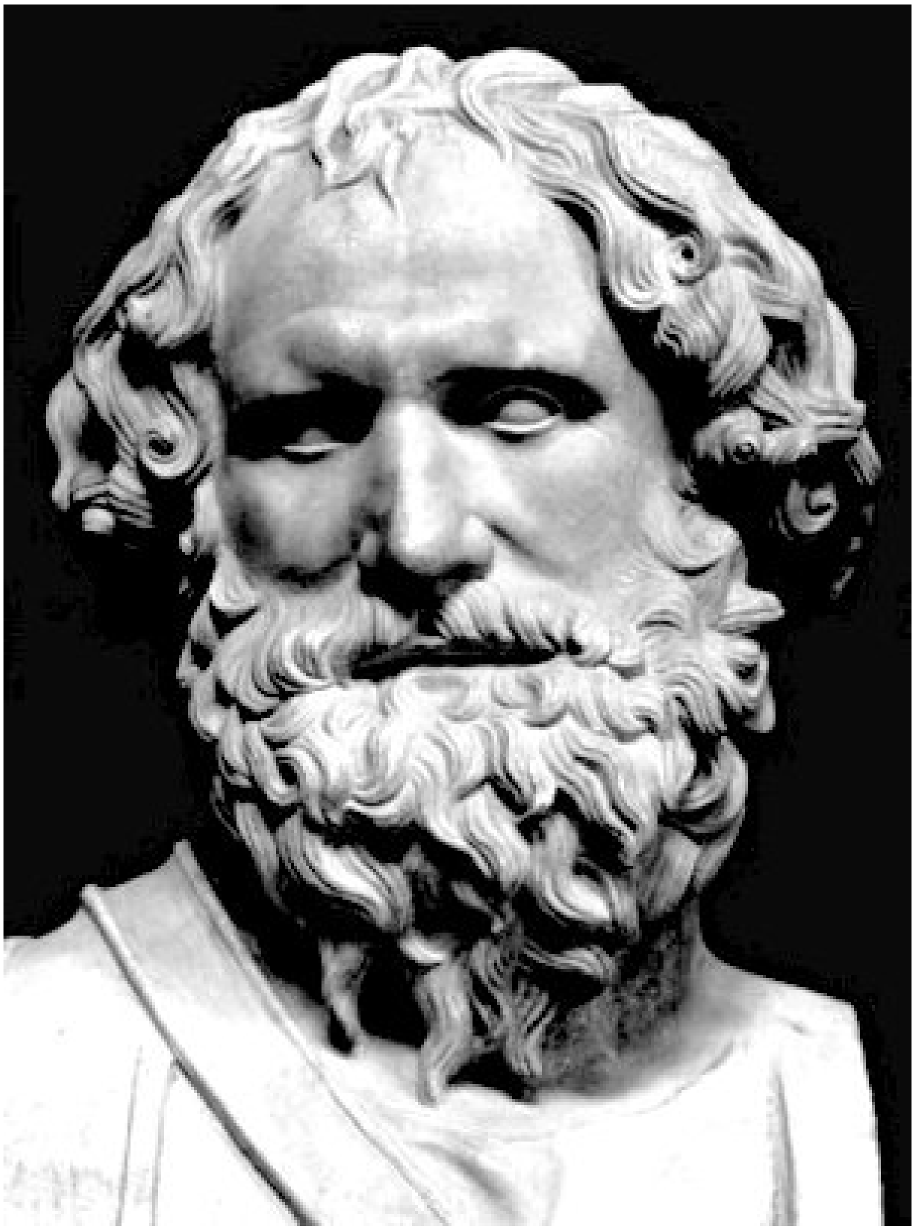

Figure 2.6: **A statue of Archimedes (287 B.C. -212 B.C.).**

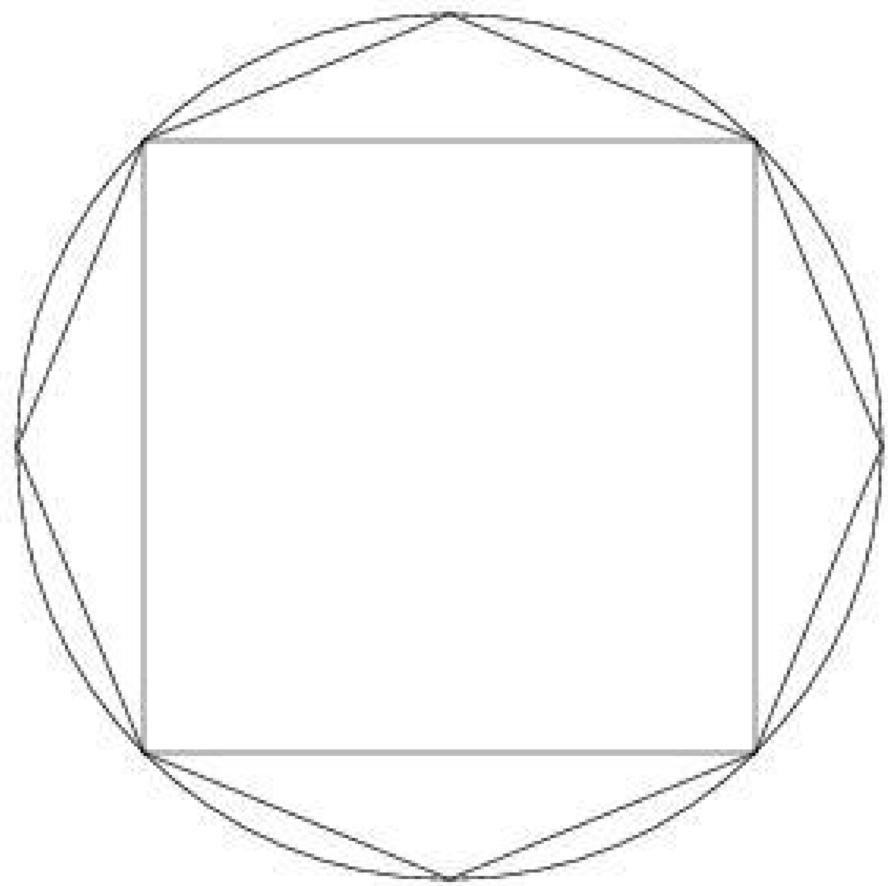

Figure 2.7: **This figure illustrates one of the ways in which Archimedes used his doctrine of limits to calculate the area of a circle. He first inscribed a square within the circle, then an octagon, then a figure with 16 sides, and so on. As the number of sides became very large, the area of these figures (which he could calculate) approached the true area of the circle.**

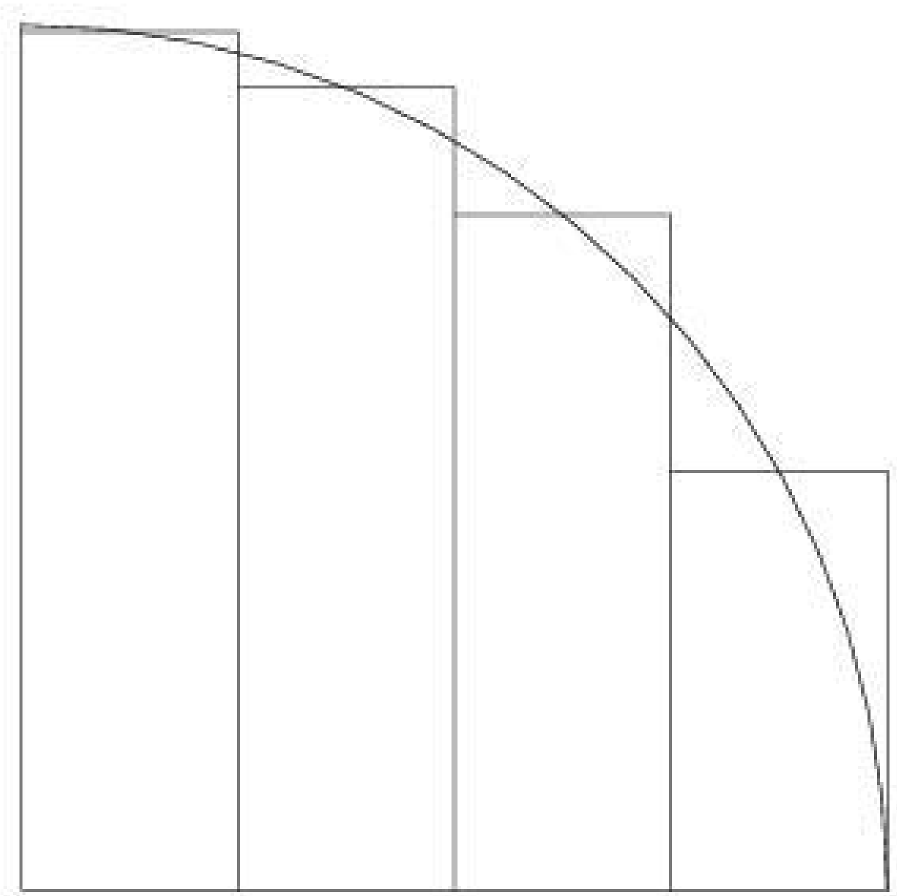

Figure 2.8: **Here we see another way in which Archimedes used his doctrine of limits. He could calculate the areas of figures bounded by curves by dividing up these areas into a large number of narrow strips. As the number of strips became very large, their total area approached the true area of the figure.**

true area of the circle.

Archimedes also circumscribed polygons about the circle, and thus he obtained an upper limit for the area, as well as a lower limit. The true area was trapped between the two limits. In this way, Archimedes showed that the value of pi lies between 223/71 and 220/70.

Sometimes Archimedes' use of the doctrine of limits led to exact results. For example, he was able to show that the ratio between the volume of a sphere inscribed in a cylinder to the volume of the cylinder is 2/3, and that the area of the sphere is 2/3 the area of the cylinder. He was so pleased with this result that he asked that a sphere and a cylinder be engraved on his tomb, together with the ratio, 2/3.

Another problem which Archimedes was able to solve exactly was the problem of calculating the area of a plane figure bounded by a parabola. In his book *On method*, Archimedes says that it was his habit to begin working on a problem by thinking of a plane figure as being composed of a very large number of narrow strips, or, in the case of a solid, he thought of it as being built up from a very large number of slices. This is exactly the approach which is used in integral calculus.

Archimedes must really be credited with the invention of both differential and integral calculus. He used what amounts to integral calculus to find the volumes and areas not only of spheres, cylinders and cones, but also of spherical segments, spheroids, hyperboloids and paraboloids of revolution; and his method for constructing tangents anticipates differential calculus.

Unfortunately, Archimedes was unable to transmit his invention of the calculus to the other mathematicians of his time. The difficulty was that there was not yet any such thing as algebraic geometry. The Pythagoreans had never recovered from the shock of discovering irrational numbers, and they had therefore abandoned algebra in favor of geometry. The union of algebra and geometry, and the development of a calculus which even non-geniuses could use, had to wait for Descartes, Fermat, Newton and Leibniz.

Archimedes was the father of statics (as well as of hydrostatics). He calculated the centers of gravity of many kinds of figures, and he made a systematic, quantitative study of the properties of levers. He is supposed to have said: "Give me a place to stand on, and I can move the world!" This brings us to another of the stories about Archimedes: According to the story, Hieron was a bit sceptical, and he challenged Archimedes to prove his statement by moving something rather enormous, although not necessarily as large as the world. Archimedes good-humoredly accepted the challenge, hooked up a system of pulleys to a fully-loaded ship in the harbor, seated himself comfortably, and without excessive effort he singlehandedly pulled the ship out of the water and onto the shore.

Archimedes had a very compact notation for expressing large numbers. Essentially his system was the same as our own exponential notation, and it allowed him to handle very large numbers with great ease. In a curious little book called *The Sand Reckoner*, he used this notation to calculate the number of grains of sand which would be needed to fill the universe. (Of course, he had to make a crude guess about the size of the universe.) Archimedes wrote this little book to clarify the distinction between things which are very large but finite and things which are infinite. He wanted to show that nothing finite - not

Figure 2.9: **The death of Archimedes. In reply to the orders of a Roman soldier, Archimedes said, "Don't disturb my circles". The soldier immediately killed him.**

even the number of grains of sand needed to fill the universe - is too large to be measured and expressed in numbers. *The Sand Reckoner* is important as an historical document, because in it Archimedes incidentally mentions the revolutionary heliocentric model of Aristarchus, which does not occur in the one surviving book by Aristarchus himself.

In addition to his mathematical genius, Archimedes showed a superb mechanical intuition, similar to that of Leonardo da Vinci. Among his inventions are a planetarium and an elegant pump in the form of a helical tube. This type of pump is called the "screw of Archimedes", and it is still in use in Egypt. The helix is held at an angle to the surface of the water, with its lower end half-immersed. When the helical tube is rotated about its long axis, the water is forced to flow uphill!

His humanity and his towering intellect brought Archimedes universal respect, both during his own lifetime and ever since. However, he was not allowed to live out his life in peace; and the story of his death is both dramatic and symbolic:

In c. 212 B.C., Syracuse was attacked by a Roman fleet. The city would have fallen quickly if Archimedes had not put his mind to work to think of ways to defend his countrymen. He devised systems of mirrors which focused the sun's rays on the attacking ships and set them on fire, and cranes which plucked the ships from the water and overturned them.

In the end, the Romans hardly dared to approach the walls of Syracuse. However, after several years of siege, the city fell to a surprise attack. Roman soldiers rushed through the streets, looting, burning and killing. One of them found Archimedes seated calmly in front of diagrams sketched in the sand, working on a mathematical problem. When the soldier ordered him to come along, the great mathematician is supposed to have looked up from his work and replied: "Don't disturb my circles." The soldier immediately killed him.

The death of Archimedes and the destruction of the Hellenistic civilization illustrate the fragility of civilization. It was only a short step from Archimedes to Galileo and Newton; only a short step from Eratosthenes to Columbus, from Aristarchus to Copernicus, from Aristotle to Darwin or from Hippocrates to Pasteur. These steps in the cultural evolution of mankind had to wait nearly two thousand years, because the brilliant Hellenistic civilization was destroyed, and Europe was plunged back into the dark ages.

2.7 Roman engineering

During the period between 202 B.C. and 31 B.C., Rome gradually extended its control over the Hellenistic states. By intervening in a dynastic struggle between Cleopatra and her brother Ptolemy, Julius Caesar was able to obtain control of Egypt. He set fire to the Egyptian fleet in the harbor of Alexandria. The fire spread to the city. Soon the great library of Alexandria was in flames, and most of its 750,0000 volumes were destroyed. If these books had survived, our knowledge of the history, science and literature of the ancient world would be incomparably richer. Indeed, if the library had survived, the whole history of the world might have been very different.

The Roman conquest produced 600 years of political stability in the west, and it helped to spread civilization into northern Europe. The Roman genius was for practical organization, and for useful applications of knowledge such as engineering and public health.

Roman roads, bridges and aqueducts, many of them still in use, testify to the superb skill of Roman engineers. The great system of aqueducts which supplied Rome with water brought the city a million cubic meters every day. Under the streets of Rome, a system of sewers (*cloacae*), dating from the 6th century B.C., protected the health of the citizens.

The abacus was used in Rome as an aid to arithmetic. This device was originally a board with a series of groves in which pebbles (*calculi*) were slid up and down. Thus the English word "calculus" is derived from the Latin name for a pebble.

The impressive technical achievements of the Roman Empire were in engineering, public health and applied science, rather than in pure science. In the 5th century A.D., the western part of the Roman Empire was conquered by barbaric tribes from northern Europe, and the west entered a dark age.

Figure 2.10: **The Roman Baths in the city of Bath, England.**

Figure 2.11: **The Alcántara Bridge, Spain, a masterpiece of ancient bridge building.**

Figure 2.12: **A Roman aqueduct: The multiple arches of the Pont du Gard in Roman Gaul (modern-day southern France). The upper tier encloses an aqueduct that carried water to Nimes in Roman times; its lower tier was expanded in the 1740s to carry a wide road across the river.**

Figure 2.13: **The exterior of the Colosseum, showing the partially intact outer wall (left) and the mostly intact inner wall (center and right). The outer wall is estimated to have required over 100,000 cubic meters (3,531,467 cubic feet) of travertine stone which were set without mortar; they were held together by 300 tons of iron clamps.**

Figure 2.14: **A Roman street in Pompeii. At the peak of Rome's development, the late Empire's 113 provinces were interconnected by 372 great roads. The total length of these roads was more than 400,000 kilometers (250,000 miles).**

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Chapter 3

CHINESE CIVIL SERVICE AND SCHOLAR-GENTRY FAMILIES

3.1 The high level of Chinese civilization

After the fall of Rome in the 5th century A.D., Europe became a culturally backward area. However, the great civilizations of Asia and the Middle East continued to flourish, and it was through contact with these civilizations that science was reborn in the west.

During the dark ages of Europe, a particularly high level of civilization existed in China. The art of working in bronze was developed in China during the Shang dynasty (1,500 B.C. - 1,100 B.C.) and it reached a high pitch of excellence in the Chou dynasty (1,100 B.C. - 250 B.C.).

In the Chou period, many of the cultural characteristics which we recognize as particularly Chinese were developed. During this period, the Chinese evolved a code of behavior based on politeness and ethics. Much of this code of behavior is derived from the teachings of K'ung Fu-tzu (Confucius), a philosopher and government official who lived between 551 B.C. and 479 B.C.. In his writings about ethics and politics, K'ung Fu-tzu advocated respect for tradition and authority, and the effect of his teaching was to strengthen the conservative tendencies in Chinese civilization. He was not a religious leader, but a moral and political philosopher, like the philosophers of ancient Greece. He is traditionally given credit for the compilation of the Five Classics of Chinese Literature, which include books of history, philosophy and poetry, together with rules for religious ceremonies.

The rational teachings of K'ung Fu-tzu were complemented by the more mystical and intuitive doctrines of Lao-tzu and his followers. Lao-tzu lived at about the same time as K'ung Fu-tzu, and he founded the Taoist religion. The Taoists believed that unity with nature could be achieved by passively blending oneself with the forces of nature.

On the whole, politicians and scholars followed the practical teachings of K'ung Fu-tzu, while poets and artists became Taoists. The intuitive sensitivity to nature inspired by Taoist beliefs allowed these artists and poets to achieve literature and art of unusual vividness and force with great economy of means. The Taoist religion has much in common

Figure 3.1: **A painting of K'ung Fu-tzu (551 B.C.- 479 B.C.). Public domain, Wikimedia Commons**

with Buddhism, and its existence in China paved the way for the spread of Buddhism from India to China and Japan.

From 800 B.C. onwards, the central authority of the Chou dynasty weakened, and China was ruled by local landlords. This period of disunity was ended in 246 B.C. by Shih Huang Ti, a chieftain from the small northern state of Ch'in, who became the first real emperor of China. (In fact, China derives its name from the state of Ch'in).

Shih Huang Ti was an effective but ruthless ruler. It was during his reign (246 B.C. -210 B.C.) that the great wall of China was built. This wall, built to protect China from the savage attacks of the mounted Mongolian hordes, is one of the wonders of the world. It runs 1,400 miles, over all kinds of terrain, marking a rainfall boundary between the rich agricultural land to the south and the arid steppes to the north.

In most places, the great wall is 25 feet high and 15 feet thick. To complete this fantastic building project, Shih Huang Ti carried absolutism to great extremes, uprooting thousands of families and transporting them to the comfortless north to work on the wall. He burned all the copies of the Confucian classics which he could find, since his opponents quoted these classics to show that his absolutism had exceeded proper bounds.

Soon after the death of Shih Huang Ti, there was a popular reaction to the harshness of his government, and Shih's heirs were overthrown. However, Shih Huang Ti's unification of China endured, although the Ch'in dynasty (250 B.C. - 202 B.C.) was replaced by the Han dynasty (202 B.C. -220 A.D.). The Han emperors extended the boundaries of China to the west into Turkestan, and thus a trade route was opened, through which China exported silk to Persia and Rome.

During the Han period, China was quite receptive to foreign ideas, and was much influenced by the civilization of India. For example, the Chinese pagoda was inspired by the Buddhist shrines of India. The Han emperors adopted Confucianism as the official philosophy of China, and they had the Confucian classics recopied in large numbers. The invention of paper at the end of the first century A.D. facilitated this project, and it greatly stimulated scholarship and literature.

The Han emperors honored scholarship and, in accordance with the political ideas of K'ung Fu-tzu, they made scholarship a means of access to high governmental positions. During the Han dynasty, the imperial government carried through many large-scale irrigation and flood-control projects. These projects were very successful. They increased the food production of China, and gave much prestige to the imperial government.

Like the Roman Empire, the Han dynasty was ended by attacks of barbarians from the north. However, the Huns who overran northern China in 220 A.D. were quicker to adopt civilization than were the tribes which conquered Rome. Also, in the south, the Chinese remained independent; and therefore the dark ages of China were shorter than the European dark ages.

In 581 A.D., China was reunited under the Sui dynasty, whose emperors expelled most of the Huns, built a system of roads and canals, and constructed huge granaries for the prevention of famine. These were worthwhile projects, but in order to accomplish them, the Sui emperors used very harsh methods. The result was that their dynasty was soon overthrown and replaced by the T'ang dynasty (618 A.D. - 906 A.D.).

The T'ang period was a brilliant one for China. Just as Europe was sinking further and further into a mire of superstition, ignorance and bloodshed, China entered a period of peace, creativity and culture. During this period, China included Turkestan, northern Indochina and Korea. The T'ang emperors re-established and strengthened the system of civil-service examinations which had been initiated during the Han dynasty.

3.2 Printing

It was during the T'ang period that the Chinese made an invention of immense importance to the cultural evolution of mankind. This was the invention of printing. Together with writing, printing is one of the key inventions which form the basis of human cultural evolution.

Printing was invented in China in the 8th or 9th century A.D., probably by Buddhist monks who were interested in producing many copies of the sacred texts which they had translated from Sanskrit. The act of reproducing prayers was also considered to be meritorious by the Buddhists.

The Chinese had for a long time followed the custom of brushing engraved official seals with ink and using them to stamp documents. The type of ink which they used was made from lamp-black, water and binder. In fact, it was what we now call "India ink". However, in spite of its name, India ink is a Chinese invention, which later spread to India, and from there to Europe.

We mentioned that paper of the type which we now use was invented in China in the first century A.D.. Thus, the Buddhist monks of China had all the elements which they needed to make printing practical: They had good ink, cheap, smooth paper, and the tradition of stamping documents with ink-covered engraved seals. The first block prints which they produced date from the 8th century A.D.. They were made by carving a block of wood the size of a printed page so that raised characters remained, brushing ink onto the block, and pressing this onto a sheet of paper.

The oldest known printed book, the "Diamond Sutra", is dated 868 A.D.., and it consists of only six printed pages. In was discovered in 1907 by an English scholar who obtained permission from Buddhist monks in Chinese Turkestan to open some walled-up monastery rooms, which were said to have been sealed for 900 years. The rooms were found to contain a library of about 15,000 manuscripts, among which was the Diamond Sutra.

Block printing spread quickly throughout China, and also reached Japan, where woodblock printing ultimately reached great heights in the work of such artists as Hiroshige and Hokusai. The Chinese made some early experiments with movable type, but movable type never became popular in China, because the Chinese written language contains 10,000 characters. However, printing with movable type was highly successful in Korea as early as the 15th century A.D..

The unsuitability of the Chinese written language for the use of movable type was the greatest tragedy of the Chinese civilization. Writing had been developed at a very early stage in Chinese history, but the system remained a pictographic system, with a different character for each word. A phonetic system of writing was never developed.

The failure to develop a phonetic system of writing had its roots in the Chinese imperial system of government. The Chinese empire formed a vast area in which many different languages were spoken. It was necessary to have a universal language of some kind in order to govern such an empire. The Chinese written language solved this problem admirably.

Suppose that the emperor sent identical letters to two officials in different districts. Reading the letters aloud, the officials might use entirely different words, although the characters in the letters were the same. Thus the Chinese written language was a sort of "Esperanto" which allowed communication between various language groups, and its usefulness as such prevented its replacement by a phonetic system.

The disadvantages of the Chinese system of writing were twofold: First, it was difficult to learn to read and write; and therefore literacy was confined to a small social class whose members could afford a prolonged education. The system of civil-service examinations made participation in the government dependant on a high degree of literacy; and hence the old, established scholar-gentry families maintained a long-term monopoly on power, wealth and education. Social mobility was possible in theory, since the civil service examinations were open to all, but in practice, it was nearly unattainable.

The second great disadvantage of the Chinese system of writing was that it was unsuitable for printing with movable type. An "information explosion" occurred in the west following the introduction of printing with movable type, but this never occurred in China. It is ironical that although both paper and printing were invented by the Chinese, the full effect of these immensely important inventions bypassed China and instead revolutionized the west.

The invention of block printing during the T'ang dynasty had an enormously stimulating effect on literature, and the T'ang period is regarded as the golden age of Chinese lyric poetry. A collection of T'ang poetry, compiled in the 18th century, contains 48,900 poems by more than 2,000 poets.

The technique of producing fine ceramics from porcelain was invented during the T'ang dynasty; and the art of making porcelain reached its highest point in the Sung dynasty (960-1279), which followed the T'ang period. During the Sung dynasty, Chinese landscape painting also reached a high degree of perfection. In this period, the Chinese began to use the magnetic compass for navigation.

The first Chinese text clearly describing the magnetic compass dates from 1088 A.D.. However, the compass is thought to have been invented in China at a very much earlier date. The original Chinese compass was a spoon carved from lodestone, which revolved on a smooth diviner's board. The historian Joseph Needham believes that sometime between the 1st and 6th centuries A.D. it was discovered in China that the directive property of the lodestone could be transferred to small iron needles. These could be placed on bits of wood and floated in water. It is thought that by the beginning of the Sung dynasty, the Chinese were also aware of the deviation of the magnetic north from the true geographical north. By 1190 A.D., knowledge of the compass had spread to the west, where it revolutionized navigation and lead to the great voyages of discovery which characterized the 15th century.

The Sung dynasty was followed by a period during which China was ruled by the Mongols (1279-1328). Among the Mongol emperors was the famous Kublai Khan, grandson of Genghis Khan. He was an intelligent and capable ruler who appreciated Chinese civilization and sponsored many cultural projects. It was during the Mongol period that Chinese drama and fiction were perfected. During this period, the Mongols ruled not only China, but also southern Russia and Siberia, central Asia and Persia. They were friendly towards Europeans, and their control of the entire route across Asia opened direct contacts between China and the west.

Among the first Europeans to take advantage of this newly-opened route were a family of Venetian merchants called Polo. After spending four years crossing central Asia and the terrible Gobi desert, they reached China in 1279. They were warmly welcomed by Kublai Khan, who invited them to his summer palace at Shangtu ("Xanadu"). The Great Khan took special interest in Marco Polo, a young man of the family who had accompanied his uncles Nicolo and Maffeo on the journey. Marco remained in China for seventeen years as a trusted diplomat in the service of Kublai Khan.

Later, after returning to Italy, Marco Polo took part in a war between Venice and Genoa. He was captured by the Genoese, and while in prison he dictated the story of his adventures to a fellow prisoner who happened to be a skilful author of romances. The result was a colorful and readable book which helped to reawaken the west after the middle ages. The era of exploration which followed the middle ages was partly inspired by Marco Polo's book. (Columbus owned a copy and made enthusiastic notes in the margins!) In his book, Marco Polo describes the fabulous wealth of China, as well as Chinese use of paper money, coal and asbestos.

Other Chinese inventions which were transmitted to the west include metallurgical blowing engines operated by water power, the rotary fan and rotary winnowing machine, the piston bellows, the draw-loom, the wheel-barrow, efficient harnesses for draught animals, the cross bow, the kite, the technique of deep drilling, cast iron, the iron-chain suspension bridge, canal lock-gates, the stern-post rudder and gunpowder. Like paper, printing and the magnetic compass, gunpowder and its use in warfare were destined to have an enormous social and political impact.

The T'ang period (618 A.D. - 906 A.D.) was a brilliant one for China. Just as Europe was sinking further and further into a mire of superstition, ignorance and bloodshed, China entered a period of peace, creativity and culture. During this period, China included Turkestan, northern Indochina and Korea. The T'ang emperors re-established and strengthened the system of civil-service examinations which had been initiated during the Han dynasty.

Figure 3.2: **A painting of Marco Polo dressed as a Tartar. Public domain, Wikimedia Commons**

3.3 Civil service examinations and the scholar-gentry

According to Wikipedia,

Scholar-officials, also known as Literati, Scholar-gentlemen, were politicians and government officials appointed by the emperor of China to perform day-to-day political duties from the Han dynasty to the end of the Qing dynasty in 1912, China's last imperial dynasty. After the Sui dynasty these officials mostly came from the scholar-gentry who had earned academic degrees (such as xiucai, juren, or jinshi) by passing the imperial examinations. The scholar-officials were schooled in calligraphy and Confucian texts. They dominated the government and local life of China until the early-20th century.

Since only a select few could become court or local officials, the majority of the scholar-literati stayed in villages or cities as social leaders. The scholar-gentry carried out social welfare measures, taught in private schools, helped negotiate minor legal disputes, supervised community projects, maintained local law and order, conducted Confucian ceremonies, assisted in the governments collection of taxes, and preached Confucian moral teachings. As a class, these scholars claimed to represent morality and virtue. The district magistrate, who by regulation was not allowed to serve in his home district, depended on the local gentry for advice and for carrying out projects, which gave them the power to benefit themselves and their clients.

Theoretically, this system would create a meritocratic ruling class, with the best students running the country. The examinations gave many people the opportunity to pursue political power and honor - and thus encouraged serious pursuit of formal education. Since the system did not formally discriminate based on social status, it provided an avenue for upward social mobility. However, even though the examination-based bureaucracy's heavy emphasis on Confucian literature ensured that the most eloquent writers and erudite scholars achieved high positions, the system lacked formal safeguards against political corruption, only the Confucian moral teachings tested by the examinations.

Figure 3.3: **A 15th-century portrait of the Ming official Jiang Shunfu. The two cranes on his chest are a "Mandarin square" for a civil official of the first rank.**

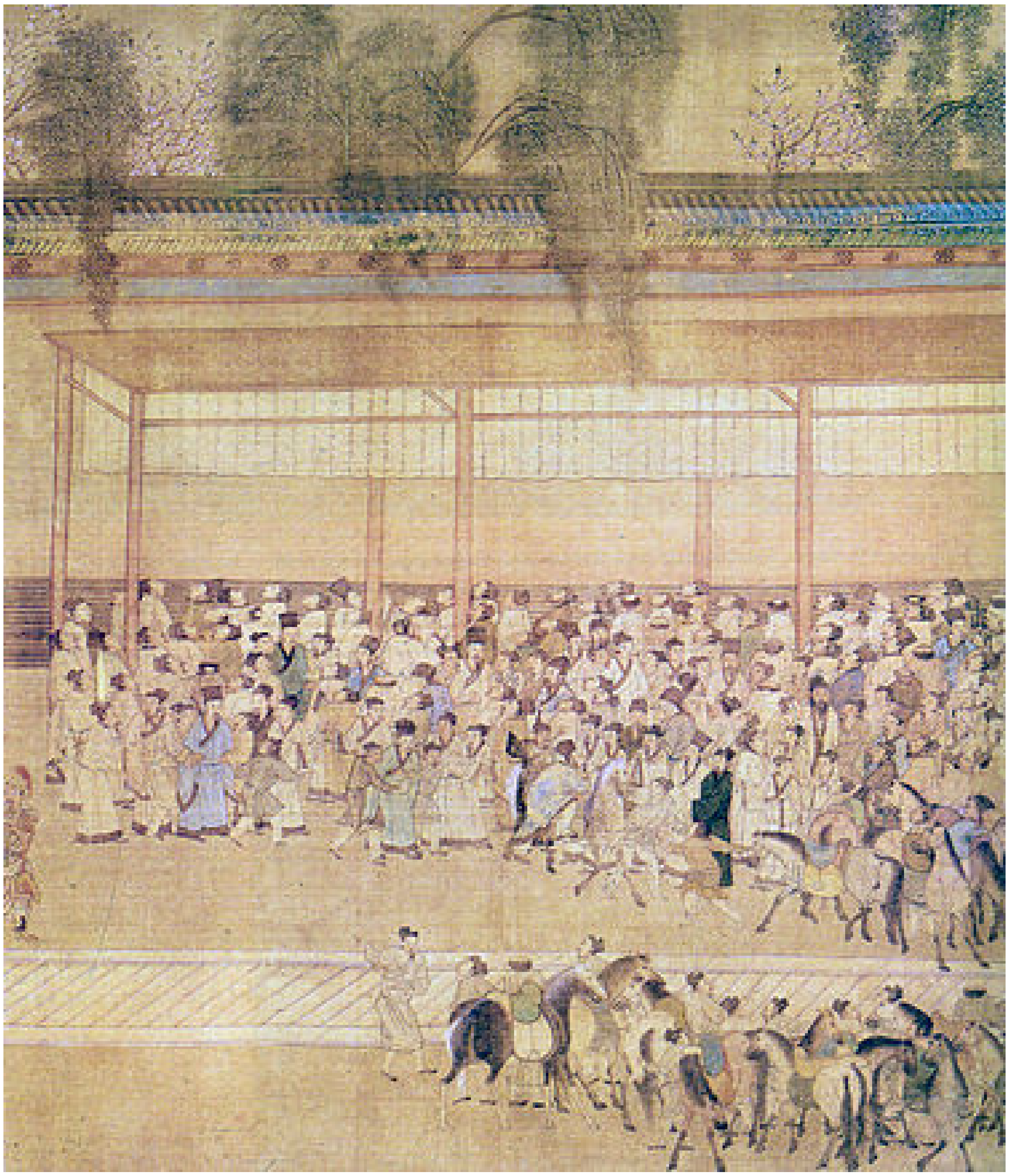

Figure 3.4: **Candidates gathering around the wall where the results are posted. This announcement was known as "releasing the roll". (c. 1540, by Qiu Ying).**

Figure 3.5: **The emperor receives a candidate during the Palace Examination. Song dynasty.**

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Chapter 4

EDUCATION IN ANCIENT INDIA

4.1 Early civilization in India

Evidence of a very early river-valley civilization in India has been found at a site called Mohenjo-Daro. However, in about 2,500 B.C., this early civilization was destroyed by some great disaster, perhaps a series of floods; and for the next thousand years, little is known about the history of India. During this dark period between 2,500 B.C. and 1,500 B.C., India was invaded by the Indo-Aryans, who spoke Sanskrit, a language related to Greek. The Indo-Aryans partly drove out and partly enslaved the smaller and darker native Dravidians. However, there was much intermarriage between the groups, and to prevent further intermarriage, the Indo-Aryans introduced a caste system sanctioned by religion.

According to Hindu religious belief, the soul of a person who has died is reborn in another body. If, throughout his life, the person has faithfully performed the duties of his caste, then his or her soul may be reborn into a higher caste. Finally, after existing as a Brahman, the soul may be so purified that it can be released from the cycle of death and rebirth.

In the 6th century B.C., Gautama Buddha founded a new religion in India. Gautama Buddha was convinced that all the troubles of humankind spring from attachment to earthly things. He felt that the only escape from sorrow is through the renunciation of earthly desires. He also urged his disciples to follow a high ethical code, the Eightfold Way. Among the sayings of Buddha are the following:

"Hatred does not cease by hatred at any time; hatred ceases by love."

"Let a man overcome anger by love; let him overcome evil by good."

"All men tremble at punishment. All men love life. Remember that you are like them, and do not cause slaughter."

One of the early converts to Buddhism was the emperor Ashoka Maurya, who reigned in India between 273 B.C. and 232 B.C.. During one of his wars of conquest, Ashoka Maurya became so sickened by the slaughter that he resolved never again to use war as an instrument of policy. He became one of the most humane rulers in history, and he also did much to promote the spread of Buddhism throughout Asia.

Under the Mauryan dynasty (322 B.C. - 184 B.C.), the Gupta dynasty (320 B.C. - 500 A.D.) and also under the rajah Harsha (606 A.D. - 647 A.D.), India had periods of unity, peace and prosperity. At other times, the country was divided and upset by internal wars. The Gupta period especially is regarded as the golden age of India's classical past. During this period, India led the world in such fields as medicine and mathematics.

4.2 Medicine in ancient India

The Guptas established both universities and hospitals. According to the Chinese Buddhist pilgrim, Fa-Hsien, who visited India in 405 A.D., "The nobles and householders have founded hospitals within the city to which the poor of all countries, the destitute, crippled and diseased may go. They receive every kind of help without payment."

Indian doctors were trained in cleansing wounds, in using ointments and in surgery. They also developed antidotes for poisons and for snakebite, and they knew some techniques for the prevention of disease through vaccination.

When they had completed their training, medical students in India took an oath, which resembled the Hippocratic oath: "Not for yourself, not for the fulfillment of any earthly desire or gain, but solely for the good of suffering humanity should you treat your patients."

According to an article by Tejraj Aminabhavi in Asian Review[1], "Among India's many claims to fame is the ancient medical science known as Ayurveda (from the Sanskrit words ayur, or life, and veda, science). This is a healing method that relies on herbs as medicines for maintaining good health. The 5,000-year-old system of natural healing is originated in India's ancient Vedic culture. It was suppressed during the years of foreign occupation, but its medical practices have been enjoying a resurgence both in its native land and throughout the world.

"Early Greek medicine embraced many concepts originally described in classical Ayurvedic texts dating back thousands of years. Traditional Tibetan and Chinese medicine also have roots in Ayurveda. Over time, Ayurveda has become the science of life, encompassing body, mind and spirit. This body of knowledge is believed to have been originally delivered by God to sages and seers, who were yogis renowned in their insight, intuition and keen observation of human behavior. They handed down their knowledge to their disciples. An important goal of Ayurveda is to identify the ideal state of balance of a person and offer solutions using diet, herbs, music, massage treatments and meditation to restore the body's balance.

"The key concepts of Ayurvedic medicine are based on universal interconnections among people, their health, the universe, the body's constitution and life forces that are often compared to the "humors" of the ancient Greek system. Using these concepts, Ayurvedic physicians prescribe individualized treatments that include herbs, diet and exercise along with lifestyle recommendations. The majority of the Indian population today uses Ayurvedic medicine, combined with conventional Western medicine, a practice popular all over Southeast Asia as well."

[1] https://asia.nikkei.com/Business/Science/Ayurveda-the-ancient-Indian-medical-practice

4.3 Mathematics in ancient India

In Indian mathematics, algebra and trigonometry were especially highly developed. For example, the astronomer Brahmagupta (598 A.D. - 660 A.D.) applied algebraic methods to astronomical problems. The notation for zero and the decimal system were invented in India, probably during the 8th or 9th century A.D.. These mathematical techniques were later transmitted to Europe by the Arabs.

4.4 Manufacturing

Many Indian techniques of manufacture were also transmitted to the west by the Arabs. Textile manufacture in particular was highly developed in India, and the Arabs, who were the middlemen in the trade with the west, learned to duplicate some of the most famous kinds of cloth. One kind of textile which they copied was called "quttan" by the Arabs, a word which in English has become "cotton". Other Indian textiles included cashmere (Kashmir), chintz and calico (from Calcutta, which was once called Calicut). Muslin derives its name from Mosul, an Arab city where it was manufactured, while damask was made in Damascus.

Indian mining and metallurgy were also highly developed. The Europeans of the middle ages prized fine laminated steel from Damascus; but it was not in Damascus that the technique of making steel originated. The Arabs learned steelmaking from the Persians, and Persia learned it from India.

Figure 4.1: **An ancient astronomical observatory in India.**

Figure 4.2: **A another ancient Indian astronomical observatory.**

4.5 The Vedic period, (1500 BC - 500 BC)

Here are some excerpts from an article by Charu Sethi, entitled *Indian Education System in Ancient India*[2]:

The main features of Vedic education are:

- **In ancient India, teaching was considered to be a holy duty, which a Brahman was bound to discharge, irrespective of the consideration of the fee. Teachers were expected to devote their lives to the cause of education.**
- **Teachers behaved as parents to their pupils, and pupils behaved as members of their teacher's families.**
- **The immediate aim of education was to prepare different caste people for their actual needs in life.**
- **The subjects of instruction varied according to the different needs of the caste. So curriculum was related to the vocational needs of the people.**
- **The method of study consisted in listening to the teacher, its reflection, revision and discussion.**
- **Focus was more on moral, religious and spiritual education.**
- **The medium of instruction was Sanskrit.**
- **Self-control and self-discipline were considered to be the best discipline.**
- **Science education was very prominent in ancient India. Vedic science included astronomy, mathematics, chemistry and biology. The Athrava Veda was known as the science of medicine.**
- **Rulers of the country had very little directly to do with education. It was a private affair of people, managed entirely by the Brahmans.**

4.6 Buddhist period (500 BC - 1200 AD)

The rigidities of the Vedic rituals and sacrifices and the dominance of Brahmans over the lower caste became responsible for the disenchantment of the masses with the system. Gautama Buddha, the great religious leader as well as social reformer, preached non-violence and social equality. As a result, the social discrimination in the field of education that was prevalent in the Vedic period was challenged in this period.

[2] IRJMSH, Vol 6, Issue 6, 2015

Figure 4.3: **A teacher and his students.**

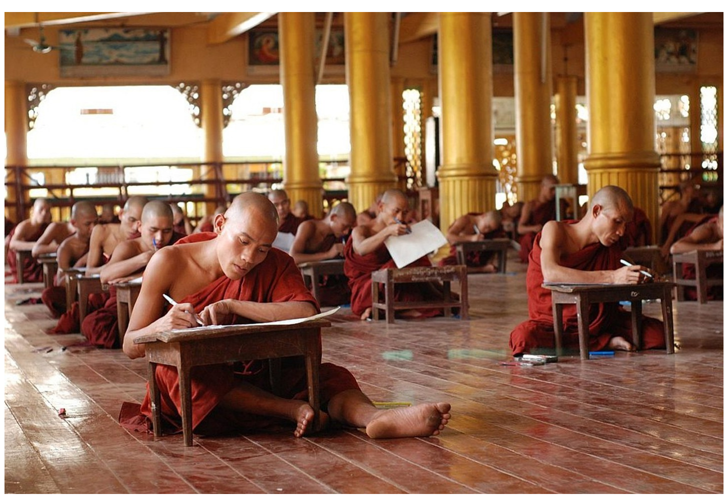

Figure 4.4: **Monks taking an exam.**

Figure 4.5: **Students praying before lunch.**

Figure 4.6: **Teaching painting.**

Figure 4.7: **Learning the Vedas.**

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Chapter 5

EDUCATION IN THE ISLAMIC WORLD

5.1 The Nestorians and Islam

After the burning of the great library at Alexandria and the destruction of Hellenistic civilization, most of the books of the classical Greek and Hellenistic philosophers were lost. However, a few of these books survived and were translated from Greek, first into Syriac, then into Arabic and finally from Arabic into Latin. By this roundabout route, fragments from the wreck of the classical Greek and Hellenistic civilizations drifted back into the consciousness of the west.

We mentioned that the Roman empire was ended in the 5th century A.D. by attacks of barbaric Germanic tribes from northern Europe. However, by that time, the Roman empire had split into two halves. The eastern half, with its capital at Byzantium (Constantinople), survived until 1453, when the last emperor was killed vainly defending the walls of his city against the Turks.

The Byzantine empire included many Syriac-speaking subjects; and in fact, beginning in the 3rd century A.D., Syriac replaced Greek as the major language of western Asia. In the 5th century A.D., there was a split in the Christian church of Byzantium;and the Nestorian church, separated from the official Byzantine church. The Nestorians were bitterly persecuted by the Byzantines, and therefore they migrated, first to Mesopotamia, and later to south-west Persia. (Some Nestorians migrated as far as China.)

During the early part of the middle ages, the Nestorian capital at Gondisapur was a great center of intellectual activity. The works of Plato, Aristotle, Hippocrates, Euclid, Archimedes, Ptolemy, Hero and Galen were translated into Syriac by Nestorian scholars, who had brought these books with them from Byzantium.

Among the most distinguished of the Nestorian translators were the members of a family called Bukht-Yishu (meaning "Jesus hath delivered"), which produced seven generations of outstanding scholars. Members of this family were fluent not only in Greek and Syriac, but also in Arabic and Persian.

In the 7th century A.D., the Islamic religion suddenly emerged as a conquering and proselytizing force. Inspired by the teachings of Mohammad (570 A.D. - 632 A.D.), the Arabs and their converts rapidly conquered western Asia, northern Africa, and Spain. During the initial stages of the conquest, the Islamic religion inspired a fanaticism in its followers which was often hostile to learning. However, this initial fanaticism quickly changed to an appreciation of the ancient cultures of the conquered territories; and during the middle ages, the Islamic world reached a very high level of culture and civilization.

Thus, while the century from 750 to 850 was primarily a period of translation from Greek to Syriac, the century from 850 to 950 was a period of translation from Syriac to Arabic. It was during this latter century that Yuhanna Ibn Masawiah (a member of the Bukht-Yishu family, and medical advisor to Caliph Harun al-Rashid) produced many important translations into Arabic.

The skill of the physicians of the Bukht-Yishu family convinced the Caliphs of the value of Greek learning; and in this way the family played an extremely important role in the preservation of the western cultural heritage. Caliph al-Mamun, the son of Harun al-Rashid, established at Baghdad a library and a school for translation, and soon Baghdad replaced Gondisapur as a center of learning.

5.2 Outstanding Islamic contributions to civilization

The English word "chemistry" is derived from the Arabic words *"al-chimia"*, which mean "the changing". The earliest alchemical writer in Arabic was Jabir (760-815), a friend of Harun al-Rashid. Much of his writing deals with the occult, but mixed with this is a certain amount of real chemical knowledge. For example, in his *Book of Properties*, Jabir gives the following recipe for making what we now call lead hydroxycarbonate (white lead), which is used in painting and pottery glazes:

"Take a pound of litharge, powder it well and heat it gently with four pounds of vinegar until the latter is reduced to half its original volume. The take a pound of soda and heat it with four pounds of fresh water until the volume of the latter is halved. Filter the two solutions until they are quite clear, and then gradually add the solution of soda to that of the litharge. A white substance is formed, which settles to the bottom. Pour off the supernatant water, and leave the residue to dry. It will become a salt as white as snow."

Another important alchemical writer was Rahzes (c. 860 - c. 950). He was born in the ancient city of Ray, near Teheran, and his name means "the man from Ray". Rhazes studied medicine in Baghdad, and he became chief physician at the hospital there. He wrote the first accurate descriptions of smallpox and measles, and his medical writings include methods for setting broken bones with casts made from plaster of Paris. Rahzes was the first person to classify substances into vegetable, animal and mineral. The word *"al-kali"*, which appears in his writings, means "the calcined" in Arabic. It is the source of our word "alkali", as well as of the symbol K for potassium.

The greatest physician of the middle ages, Avicenna, (Abu-Ali al Hussain Ibn Abdullah Ibn Sina, 980-1037), was also a Persian, like Rahzes. More than a hundred books are at-

Figure 5.1: **A painting of Caliph Harun al-Rashid.**

tributed to him. They were translated into Latin in the 12th century, and they were among the most important medical books used in Europe until the time of Harvey. Avicennna also wrote on alchemy, and he is important for having denied the possibility of transmutation of elements.

In mathematics, one of the most outstanding Arabic writers was al-Khwarizmi (c. 780 - c. 850). The title of his book, *Ilm al-jabr wa'd muqabalah*, is the source of the English word "algebra". In Arabic *al-jabr* means "the equating". Al-Khwarizmi's name has also become an English word, "algorism", the old word for arithmetic. Al-Khwarizmi drew from both Greek and Hindu sources, and through his writings the decimal system and the use of zero were transmitted to the west.

One of the outstanding Arabic physicists was al-Hazen (965-1038). He made the mistake of claiming to be able to construct a machine which could regulate the flooding of the Nile. This claim won him a position in the service of the Egyptian Caliph, al-Hakim. However, as al-Hazen observed Caliph al-Hakim in action, he began to realize that if he did not construct his machine *immediately*, he was likely to pay with his life! This led al-Hazen to the rather desperate measure of pretending to be insane, a ruse which he kept up for many years. Meanwhile he did excellent work in optics, and in this field he went far beyond anything done by the Greeks.

Al-Hazen studied the reflection of light by the atmosphere, an effect which makes the stars appear displaced from their true positions when they are near the horizon; and he calculated the height of the atmospheric layer above the earth to be about ten miles. He also studied the rainbow, the halo, and the reflection of light from spherical and parabolic

Figure 5.2: **In mathematics, one of the most outstanding Arabic writers was al-Khwarizmi (c.780 - c.850), commemorated here on a Russian stamp Public domain, Wikimedia Commons**

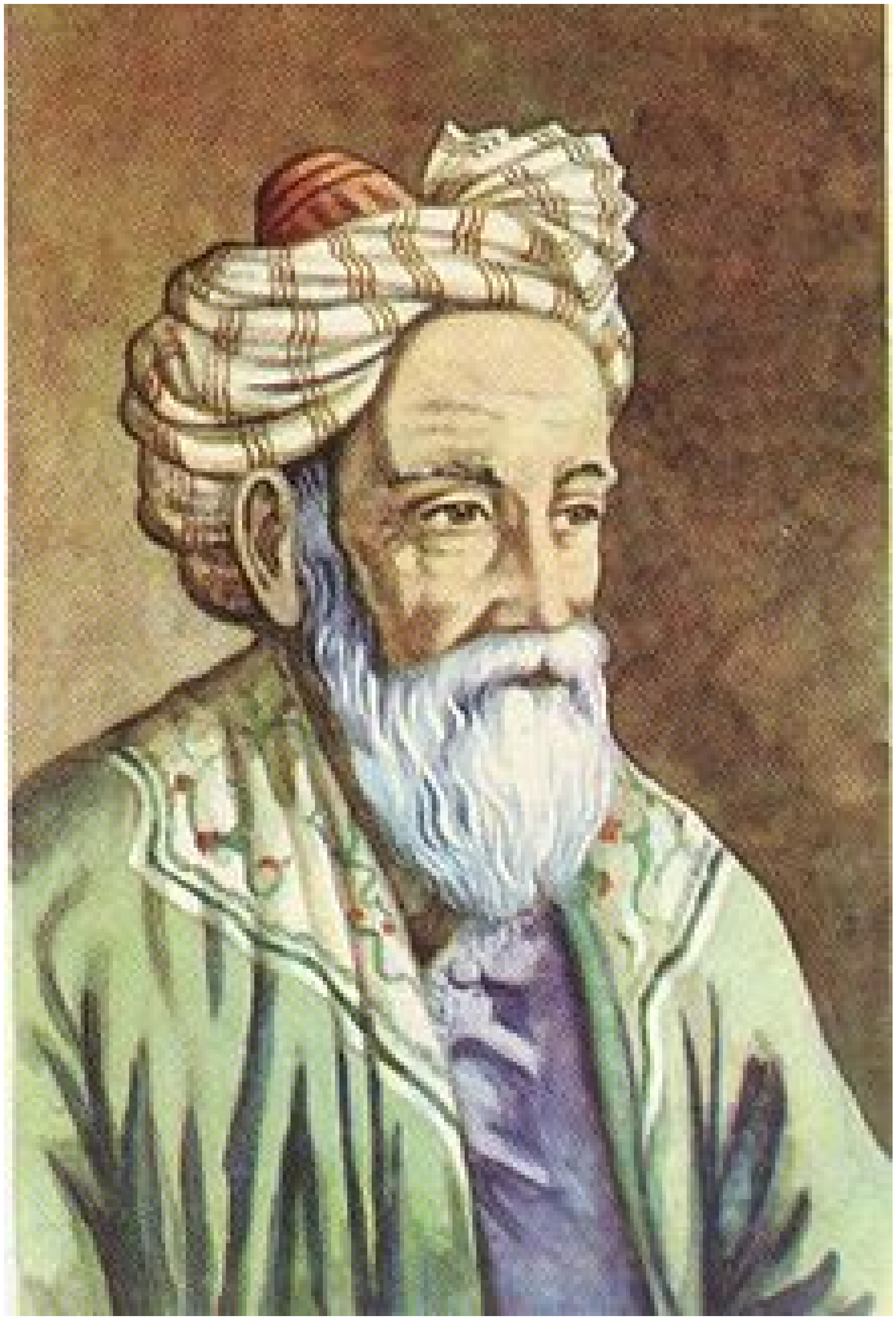

Figure 5.3: **Omar Khayyam (1048-1131) was a Persian mathematician, astronomer and poet. His work in mathematics was notable for his solutions to cubic equations, his understanding of the binomial theorem, and his discussions of the axioms of Euclid. As an astronomer, he directed the building of an observatory to reform the Persian calendar. Omar Khayyam's long poem, *Rubaiyat*, is known to western readers through Edward Fitzgerald's brilliant translation.**

mirrors. In his book, *On the Burning Sphere*, he shows a deep understanding of the properties of convex lenses. Al-Hazen also used a dark room with a pin-hole opening to study the image of the sun during an eclipse. This is the first mention of the *camera obscura*, and it is perhaps correct to attribute the invention of the *camera obscura* to al-Hazen.

Another Islamic philosopher who had great influence on western thought was Averröes, who lived in Spain from 1126 to 1198. His writings took the form of thoughtful commentaries on the works of Aristotle. He shocked both his Moslem and his Christian readers by maintaining that the world was not created at a definite instant, but that it instead evolved over a long period of time, and is still evolving.

Like Aristotle, Averröes seems to have been groping towards the ideas of evolution which were later developed in geology by Steno, Hutton and Lyell and in biology by Darwin and Wallace. Much of the scholastic philosophy which developed at the University of Paris during the 13th century was aimed at refuting the doctrines of Averröes; but nevertheless, his ideas survived and helped to shape the modern picture of the world.

Figure 5.4: **Avicenna (c.980-1037) was a Persian astronomer, philosopher, and physician. He was one of the most influential thinkers of the Islamic Golden Age. Of the 450 works he is believed to have written, around 240 have survived, including 150 on philosophy and 40 on medicine. Avicenna's famous book. "The Canon of Medicine", was a standard medical text in many midievil European universities, and was still in use as late as 1650. The statue of Avicenna shown here is in the United Nations Office in Vienna.**

Figure 5.5: **Ulugh Beg (1394-1449), whose statue is shown here, was the ruler of the Samarkand region of present-day Uzbekistan. He was also a notable astronomer and mathematician. Ulugh Beg made important contributions to spherical geometry and trigonometry. For example, he made tables of trigonometric functions which are accurate to five significant figures. He spoke five languages, including Arabic, Persian, Turkic, Mongolian, and a little Chinese.**

5.3 East-West exchanges in Toledo

In the 12th century, parts of Spain, including the city of Toledo, were reconquered by the Christians. Toledo had been an Islamic cultural center, and many Muslim scholars, together with their manuscripts, remained in the city when it passed into the hands of the Christians. Thus Toledo became a center for the exchange of ideas between east and west; and it was in this city that many of the books of the classical Greek and Hellenistic philosophers were translated from Arabic into Latin.

Toledo had been an Islamic cultural center, and many Moslem scholars, together with their manuscripts, remained in the city when it passed into the hands of the Christians. Thus Toledo became a center for the exchange of ideas between east and west; and it was in this city that many of the books of the classical Greek and Hellenistic philosophers were translated from Arabic into Latin. By this roundabout route the culture that was lost because of the burning of the Great Library at Alexandria reentered the consciousness of Europe and contributed to the Renaissance.

In the 12th century, the translation was confined to books of science and philosophy. Classical Greek literature was forbidden by both the Christian and Moslem religions; and the beautiful poems and dramas of Homer, Sophocles and Euripides were not translated into Latin until the time of the Renaissance Humanists.

It is interesting and inspiring to visit Toledo. A tourist there can see ample evidence of

Figure 5.6: **Mosaics at the Alhambra**

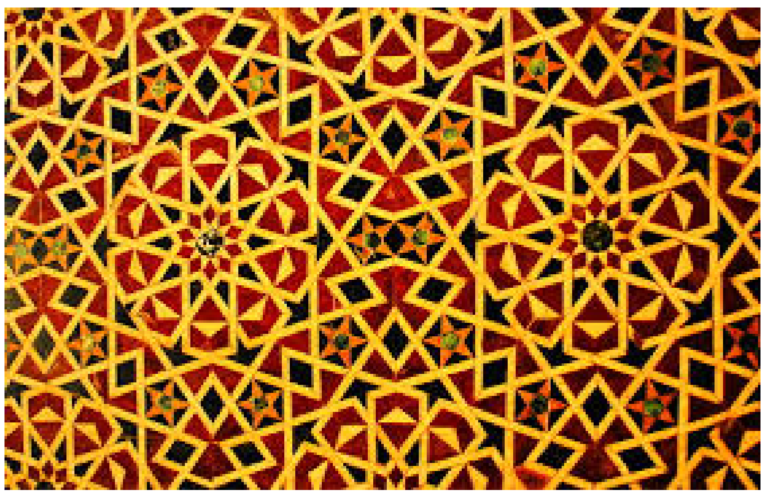

Figure 5.7: **Mosaics at the Alhambra**

a period of tolerance and enlightenment, when members of the three Abrahamic religions, Christianity, Judaism and Islam , lived side by side in harmony and mutual respect, exchanging important ideas which were to destined to become the foundations of our modern civilization. One can also see a cathedral, a mosque and a synagogue, in each of which craftsmen from all three faiths worked cooperatively to produce a beautiful monument to human solidarity.

Figure 5.8: **The interior of the great mosque at Isfahan**

Figure 5.9: **A view of Toledo**

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Chapter 6

EUROPE'S OLDEST UNIVERSITIES

European universities grew out of the earlier traditions of monastic scholarship. Below is a list of some of the oldest universities in Europe,

6.1 University of Bologna, Italy, 1088

The University of Bologna is the oldest continuously operating university in the world. At its start in 1088, it was a collection of foreign students and professors. The foreign students of a particular nation could be punished collectively for the debts or misdemeanors of any student of that nation, and the students joined together to protest against this collective punishment. The students also joined together to hire or fire the professors.

Later in the evolution of the University of Bologna, collective punishment of the students was abolished, and the salaries of the professors were paid by the city. The influence of the university increased because the city of Bologna derived many revenues from the presence of the students.

Famous alumnae of the University of Bologna include Albrecht Dürer, Dante Alighieri, Erasmus of Rotterdam, Guglielmo Marconi, Luigi Galvani, Nicolaus Copernicus, Petrarch, Thomas Becket (Archbishop of Canterbury), Romano Prodi and Umberto Eco.

Other early Italian universities

- University of Padua, 1222
- University of Naples Federico II, 1224
- University of Sienna, 1254
- University of Macerata, 1290
- Sapienza University of Rome, 1303

Figure 6.1: **The University of Bologna.**

- University of Perugia, 1308
- University of Florence, 1321
- University of Pisa, 1343
- University of Pavia, 1361
- University of Ferrara, 1391
- University of Turin, 1404
- University of Catania, 1434
- University of Genoa, 1481

6.2 University of Paris, 1150

History of the university

According to Wikipedia,

Emerging around 1150 as a corporation associated with the cathedral school of Notre Dame de Paris, it was considered the second oldest university in Europe.[1] Officially chartered in 1200 by King Philip II of France and recognized in 1215 by Pope Innocent III, it was later often nicknamed after its theological College of Sorbonne, in turn founded by Robert de Sorbon and chartered by French King Saint Louis around 1257.

Figure 6.2: **The University of Paris was originally associated with Notre-Dame Cathedral.**

In 1793, during the French Revolution, the university was closed and by Item-27 of the Revolutionary Convention, the college endowments and buildings were sold.[3] A new University of France replaced it in 1806 with four independent faculties: the Faculty of Humanities (French: Faculté des Lettres), the Faculty of Law (later including Economics), the Faculty of Science, the Faculty of Medicine and the Faculty of Theology (closed in 1885).

In 1970, following the May 1968 events, the university was divided into 13 autonomous universities.

Famous alumni and faculty members

Among the famous people associated with the University of Paris are Thomas Aquinas, John Calvin, Denis Diderot, Voltaire, Honré de Balzac, Jean-Jaques Ampère, Henri Poincaré, Pierre and Marie Curie, Louis de Broglie, Fréderik and Irène Joliot-Curie, André Lwoff, Francois Jacob, Jaques Monod, Albert Schweitzer, Henri Bergson, Jean-Paul Sartre and T.S. Eliot.

Figure 6.3: **Denis Diderot (1713-1784) was a graduate of the University of Paris. He was editor of the first encyclopedia, an effort to put all human knowledge into a single many-volume book.**

6.3 Oxford University, England, 1096-1167

The University of Oxford is the oldest university in the English-speaking world, and the second-oldest in the entire world. It is also one of the most prestegious institutions of higher learning. More than 70 Nobel laureates and more than 50 global leaders (kings, prime ministers or presidents) have been associated with the University of Oxford.

The university is composed of 39 colleges and 6 permanent private halls. The colleges offer both living quarters and tutorials (by fellows of the colleges) to their members. The tutorials are supplemented by lectures and laboratory work in the buildings of the university, conducted by professors hired by the university as a whole.

According to Wikipedia,

Twenty-eight British prime ministers have attended Oxford, including William Gladstone, H. H. Asquith, Clement Attlee, Harold Macmillan, Edward Heath, Harold Wilson, Margaret Thatcher, Tony Blair, David Cameron, Theresa May and Boris Johnson.

Scientists who performed research in Oxford include chemist Dorothy Hodgkin who received her Nobel Prize for "determinations by X-ray techniques of the structures of important biochemical substances", Howard Florey who shared the 1945 Nobel prize "for the discovery of penicillin and its curative effect in various infectious diseases", and John B. Goodenough, who shared the Nobel Prize in Chemistry in 2019 "for the development of lithium-ion batteries". Both Richard Dawkins and Frederick Soddy studied at the university and returned for research purposes. Robert Hooke, Edwin Hubble, and Stephen Hawking all studied in Oxford.

Writers associated with Oxford include Vera Brittain, A.S. Byatt, Lewis Carroll, Penelope Fitzgerald, John Fowles, Theodor Geisel, Robert Graves, Graham Greene, Joseph Heller, Christopher Hitchens, Aldous Huxley, Samuel Johnson, C. S. Lewis, Thomas Middleton, Iris Murdoch, V.S. Naipaul, Philip Pullman, Dorothy L. Sayers, Vikram Seth, J. R. R. Tolkien, Evelyn Waugh, Oscar Wilde, the poets Percy Bysshe Shelley, John Donne, A. E. Housman, Gerard Manley Hopkins, W. H. Auden, T. S. Eliot, Wendy Perriam and Philip Larkin, and seven poets laureate: Thomas Warton, Henry James Pye, Robert Southey, Robert Bridges, Cecil Day-Lewis, Sir John Betjeman, and Andrew Motion.

Composers Hubert Parry, George Butterworth, John Taverner, William Walton, James Whitbourn and Andrew Lloyd Webber have all been involved with the university.

Actors Hugh Grant, Kate Beckinsale, Rosamund Pike, Felicity Jones, Gemma Chan, Dudley Moore, Michael Palin, Terry Jones, Anna Popplewell and Rowan Atkinson were students at the university, as were filmmakers Ken Loach and Richard Curtis.

Figure 6.4: **A view of Oxford.**

Oxford's philosophical tradition started in the medieval era, with Robert Grosseteste and William of Ockham, commonly known for Occam's razor, among those teaching at the university. Thomas Hobbes, Jeremy Bentham and the empiricist John Locke received degrees from Oxford. Though the latter's main works were written after leaving Oxford, Locke was heavily influenced by his twelve years at the university.

Figure 6.5: **Oxford: one of the University buildings.**

6.4 University of Cambridge, England, 1209

The University of Cambridge was founded when a group of scholars fled from a dangerous dispute with the townspeople of Oxford and settled in the town of Cambridge. By the time that it was safe to go back to Oxford, the University of Cambridge had been established and many students and professors remained.

Today, the University of Cambridge is one of the leading universities in the world, especially in the fields of physics, astronomy, biology, medicine, mathematics and computer science. It has many common features with Oxford, and the two universities are sometimes referred to together as “Oxbridge”. The University of Cambridge consists of 31 semi-independent colleges and 100 academic departments. Students receive tutorials from the fellows of their colleges, but also attend lectures and laboratory exercises given by the university’s professors.

According to the Wikipedia article on the University of Cambridge:

Cambridge’s libraries, of which there are over 100, hold a total of around 16 million books, around nine million of which are in Cambridge University Library, a legal deposit library. The university is home to, but independent of, the Cambridge Union - the world’s oldest debating society. The university is closely linked to the development of the high-tech business cluster known as ‘Silicon Fen’. It is the central member of Cambridge University Health Partners, an academic health science centre based around the Cambridge Biomedical Campus.

The university has educated many notable alumni, including eminent mathematicians, scientists, politicians, lawyers, philosophers, writers, actors, monarchs and other heads of state. As of October 2019, 120 Nobel Laureates, 11

Fields Medalists, 7 Turing Award winners and 14 British Prime Ministers have been affiliated with Cambridge as students, alumni, faculty or research staff. University alumni have won 194 Olympic medals.

The university's publishing arm, the Cambridge University Press, is the oldest printer and publisher in the world, and it is the second largest university press in the world.

Among the most famous of Cambridge natural philosophers is Sir Isaac Newton, who conducted many of his experiments in the grounds of Trinity College. Others are Sir Francis Bacon, who was responsible for the development of the scientific method and the mathematicians John Dee and Brook Taylor. Pure mathematicians include G. H. Hardy, John Edensor Littlewood and Augustus De Morgan; Sir Michael Atiyah, a specialist in geometry; William Oughtred, inventor of the logarithmic scale; John Wallis, first to state the law of acceleration; Srinivasa Ramanujan, the self-taught genius who made substantial contributions to mathematical analysis, number theory, infinite series and continued fractions; and James Clerk Maxwell, who brought about the "second great unification of physics" (the first being accredited to Newton) with his classical theory of electromagnetic radiation. In 1890, mathematician Philippa Fawcett was the person with the highest score in the Cambridge Mathematical Tripos exams, but as a woman was unable to take the title of 'Senior Wrangler'.

In biology, Charles Darwin, famous for developing the theory of natural selection, was an alumnus of Christ's College, although his education was intended to allow him to become a clergyman. Biologists Francis Crick and James Watson worked out a model for the three-dimensional structure of DNA while working at the Cavendish Laboratory; Cambridge graduates Maurice Wilkins and especially Rosalind Franklin produced key X-ray crystallography data, which was shared with Watson by Wilkins. Wilkins went on to help verify the proposed structure and win the Nobel Prize with Watson and Crick. More recently, Sir Ian Wilmut was part of the team responsible for the first cloning of a mammal (Dolly the Sheep in 1996), naturalist and broadcaster David Attenborough, ethologist Jane Goodall, expert on chimpanzees was a PhD student, anthropologist Dame Alison Richard, former vice-chancellor of the university, and Frederick Sanger, a biochemist known for developing Sanger sequencing and receiving two Nobel prizes.

The university can be considered the birthplace of the computer, mathematician Charles Babbage designed the world's first computing system as early as the mid-1800s. Alan Turing went on to devise what is essentially the basis for modern computing and Maurice Wilkes later created the first programmable computer. The webcam was also invented at Cambridge University.

In physics, Ernest Rutherford who is regarded as the father of nuclear physics, spent much of his life at the university where he worked closely with E. J. Williams and Niels Bohr, a major contributor to the understanding of the atom, J. J. Thomson, discoverer of the electron, Sir James Chadwick, dis-

coverer of the neutron, and Sir John Cockcroft and Ernest Walton, responsible for first splitting the atom. J. Robert Oppenheimer, leader of the Manhattan Project that developed the atomic bomb, also studied under Rutherford and Thomson. Joan Curran devised the 'chaff' technique during the Second World War to disrupt radar on enemy planes.

Astronomers Sir John Herschel, Sir Arthur Eddington, Paul Dirac, the discoverer of antimatter and one of the pioneers of quantum mechanics; Stephen Hawking, theoretical physicist and the university's long-serving Lucasian Professor of Mathematics until 2009; and Lord Martin Rees, the current Astronomer Royal and former Master of Trinity College.

Other significant scientists include Henry Cavendish, the discoverer of hydrogen; Frank Whittle, co-inventor of the jet engine; William Thomson (Lord Kelvin), who formulated the original Laws of Thermodynamics; William Fox Talbot, who invented the camera, Alfred North Whitehead, Einstein's major opponent; Sir Jagadish Chandra Bose, one of the fathers of radio science; Lord Rayleigh, who made extensive contributions to both theoretical and experimental physics in the 20th century; and Georges Lemaitre, who first proposed a Big Bang theory.

Distinguished Cambridge academics include economists such as John Maynard Keynes, Thomas Malthus, Alfred Marshall, Milton Friedman, Joan Robinson, Piero Sraffa, Ha-Joon Chang and Amartya Sen, a former Master of Trinity College. Philosophers Sir Francis Bacon, Bertrand Russell, Ludwig Wittgenstein, Leo Strauss, George Santayana, G. E. M. Anscombe, Sir Karl Popper, Sir Bernard Williams, Sir Allama Muhammad Iqbal and G. E. Moore were all Cambridge scholars, as were historians such as Thomas Babington Macaulay, Frederic William Maitland, Lord Acton, Joseph Needham, E. H. Carr, Hugh Trevor-Roper, Rhoda Dorsey, E. P. Thompson, Eric Hobsbawm, Quentin Skinner, Niall Ferguson and Arthur M. Schlesinger, Jr., and famous lawyers such as Glanville Williams, Sir James Fitzjames Stephen, and Sir Edward Coke.

Cambridge poets include Edmund Spenser, author of The Faerie Queene, the Metaphysical poets John Donne, George Herbert and Andrew Marvell, John Milton, renowned for his late epic Paradise Lost, the Restoration poet and playwright John Dryden, the pre-romantic Thomas Gray, best known his Elegy Written in a Country Churchyard, William Wordsworth and Samuel Taylor Coleridge, whose joint work Lyrical Ballads is often seen to mark the beginning of the Romantic movement, later Romantics such as Lord Byron and the postromantic Alfred, Lord Tennyson, classical scholar and lyric poet A. E. Housman, war poets Siegfried Sassoon and Rupert Brooke, modernist T. E. Hulme, confessional poets Ted Hughes, Sylvia Plath and John Berryman, and, more recently, Cecil Day-Lewis, Joseph Brodsky, Kathleen Raine and Geoffrey Hill. At least nine of the Poets Laureate graduated from Cambridge.

Actors and directors such as Sir Ian McKellen, Eleanor Bron, Miriam Margolyes, Sir Derek Jacobi, Sir Michael Redgrave, James Mason, Emma Thomp-

Figure 6.6: **The Bridge of Sighs at St John's College.**

Figure 6.7: **King's College, Cambridge.**

son, Stephen Fry, Hugh Laurie, John Cleese, Freddie Highmore, Eric Idle, Graham Chapman, Graeme Garden, Tim Brooke-Taylor, Bill Oddie, Simon Russell Beale, Tilda Swinton, Thandie Newton, Georgie Henley, Rachel Weisz, Sacha Baron Cohen, Tom Hiddleston, Sara Mohr-Pietsch, Eddie Redmayne, Dan Stevens, Jamie Bamber, Lily Cole, David Mitchell, Robert Webb, Mel Giedroyc and Sue Perkins all studied at the university, as did directors such as Mike Newell, Sam Mendes, Stephen Frears, Paul Greengrass, Chris Weitz and John Madden.

Other early universities in the United Kingdom

- University of St. Andrews, 1413
- University of Glasgow, 1451
- University of Aberdeen, 1495

6.5 University of Coimbra, Portugal, 1290

Foundation by King Denis I

The university was originally called *Studium Generale*, and it was originally located in Lisbon. However, in 1537 it was moved to Coimbra and installed in the Alacova Palace, which was purchased from the Portuguese Royal Family.

Portugal's greatest poet

One of the most famous graduates of the University of Coimbra was Luís de Camoes (c.1524-1580), who is considered to be Portugal's greatest poet. His mastery of verse has been compared to that of Shakespeare, Homer and Dante. Portuguese is sometimes called "The language of Camoes".

Student resistance to Salazar's dictatorship

According to Wikipedia,

The years of dictatorship were gruesome. Apart from the students that got 7 years in prison for toasting to freedom which led directly to the foundation of Amnesty International in 1961, in 1968 students would spend the whole night greasing streets and sidewalks with soap so the mounted police would have a hard time chasing them down to break a demonstration. It is said that a student dared a policeman to get his shoes and feet wet chasing after a cigarette lighter, thrown in the duck pond, while he had the license for it in his pocket. In those days one needed a permit to own a cigarette lighter, as imposed by Salazar to protect the matches industry.

Research Institutes at the University of Coimbra

- Association for the Development of Industrial Aerodynamics
- AIBILI (Association for Innovation and Biomedical Research on Light and Image)
- Institute of Biomedical Research in Light and Image
- Centro de Histofisiologia, Patologia Experimental e Biologia do Desenvolvimento
- Center of Cardiothoracic Surgery
- Center for Pharmaceutical Studies
- Mechanical Engineering Center
- Centre for Functional Ecology
- Center for Informatics and Systems
- Institute of Science and Engineering Materials and Surfaces
- Institute for Sustainability and Innovation in Structural Engineering
- Institute for Systems and Computers Engineering at Coimbra

- Institute of Systems and Robotics
- X-Ray Diffraction Center for Materials Research (CEMDRX)
- Centre for Computational Physics
- Center of Theoretical Physics
- Electronics and Instrumentation Center
- Instrumentation Center
- Laboratory for Instrumentation and Particle Physics - Coimbra
- Centre for Mathematics
- Molecular Chemistry-Physics
- Institute of Marine Research - Coimbra Interdisciplinary Center
- Institute of Environment and Life
- Geosciences Centre
- Centre for Social Studies
- Research Centre for Anthropology and Health
- Centre for Neuroscience and Cell Biology
- Institute of Urban and Regional Studies
- Linguagem, Interpretacao e Filosofia
- Centre for the History of Society and Culture
- Estudos ClÃ¡ssicos e HumanÃsticos
- Instituto de Estudos JornalÃsticos

Figure 6.8: **The University's Joanine Library.**

Figure 6.9: **Some of the University buildings.**

6.6 University of Valadolid, Spain, 1293

According to Wikipedia,

The youth symphonic orchestra: the Joven Orquesta de la Universidad de Valladolid (Youth Orchestra of the University of Valladolid, JOUVa) is run by students of the university, and headquartered in the Residencia Universitaria Alfonso VIII of Valladolid. Since its founding in 1998 Francisco Lara Tejero has been the artistic musical director.

The choir, the Coro de la Universidad de Valladolid[4] (Choir of the University of Valladolid), is directed by Marcos CastÃ¡n and the Early Music Group *El Parnasso*.

The theatre group is *Gente de Teatro de la Uva*, founded in 1984 with the name of People's Theatre of the Faculty of Medicine, that from 1998 became the official theater group of the university. Its director is Carlos Burguillo.

Through the Area of Extension and Culture, the university presents cultural programs throughout the year, with special emphasis on the UniversiJazz Festival and Santa Cruz.

Valladolid University supports cultural initiatives such as those developed by the *Hermandad Universitaria del Santo Cristo de la Luz*, which includes Christmas and Auto Passion. It assists in the concerts that are organized through each Vice President for University Association and with public and private partnerships.

The university library has 14 library services : they are located in Palencia, Soria and Segovia provinces, the rest are situated in Valladolid, each of them have a director. All the services are managed by a Chief Librarian and coordinated by Central Services. The book collection is available through the Almena Catalogue and UVaDoc repository.

The collection has 970,000 books, some of which are important ; for example its ancient book collection has 45,000 titles including manuscripts and incunabulum of 10th century. Periodicals: 16,000 titles, E-journals: 21,000 titles, E-books: 900, Data bases: 66. , Theses and Masters projects: 33,000. Library Services : Website, reading room, interlibrary and intercampus loan, loan (book collection), computers, e-books, bibliographic information, user education online through Moodle, subject guides, and tutorials.

Other early Spanish universities

- Complutense University of Madrid, 1293
- University of Barcelona, 1450
- University of Santiago de Compostela, 1495
- University of Valencia, 1499

Figure 6.10: **Some University buildings at Valadolid**

Figure 6.11: **Valadolid.**

6.7 Charles University, Prague, 1348

Foundation by the Holy Roman Emperor Charles IV

According to Wikipedia,

Charles University, known also as Charles University in Prague... is the oldest and largest university in the Czech Republic. Founded in 1348, it was the first university in Central Europe. It is one of the oldest universities in Europe in continuous operation. Today, the university consists of 17 faculties located in Prague, Hradec Králové and Pilsen. Its academic publishing house is Karolinum Press. The university also operates several museums and two botanical gardens.

Its seal shows its protector Emperor Charles IV, with his coats of arms as King of the Romans and King of Bohemia, kneeling in front of Saint Wenceslas, the patron saint of Bohemia. It is surrounded by the inscription, *Sigillum Universitatis Scolarium Studii Pragensis* (English: Seal of the Prague academia).

Saint Wenceslas, who lived from 911 to 935 was the "Good King Wenceslas" who is familiar to us from the Christmas carol.

Charles University was the scene of important steps towards Newton's theories of motion and gravitation. The great Danish astronomer Tycho Brahe moved to Prague after quarrelling with his royal patron in Denmark. His work was continued by Johannes Kepler, whom Tycho Brahe invited to join him in Prague. Kepler's three laws of planetary motion became the basis for Newton's universal theory of gravitation.

Jan Hus and religious reform

Jan Hus was a member of the theological faculty of Charles University. His support for John Wycliffe's teaching, and his criticism of the Catholic Church anticipated the Reformation which was later to cause bitter divisions and warfare in Europe. Charles University adopted Hussite principles, was banned by the Pope, but nevertheless continued teaching.

Albert Einstein's work at the Charles University in Prague

Albert Einstein's stay in Prague as a professor at Charles University was extraordinarily successful. During this period wrote 11 scientific works, 5 of them on radiation mathematics and on quantum theory of the solids. In March 1916 in the Leipzig *Annalen der Physik* the work *The Foundation of the General Theory of Relativity* was published and in December of the same year Einstein published his famous book *On the Special and General Theory of Relativity.* This book was later translated also into the Czech language.

Einstein wrote a special preface to this edition "I'm pleased that this little book in which the main thoughts of the theory of relativity are portrayed is now published in the national language of the country in which I found the necessary composure to give the basic thought of the general theory of relativity (1908) step by step a more definite shape so it

Figure 6.12: **Charles University, Prague**

Figure 6.13: **Some Charles University buildings.**

could be realized. In the quiet rooms of the Theoretical Physical Institute of the Prague German University in the Vinicna ulice I discovered in 1911 that the equivalence principle demands a refraction of the rays of light at the sun of a sum that can be observed without knowing that more than a hundred years before a similar conclusion out of the Newton mechanic in connection with Newton's emission theory of the light was drawn. Also the still not really confirmed consequence of the red shift of the spectral lines I discovered in Prague."

6.8 Jagalonian University, Poland, 1364

According to Wikipedia,

Founded in 1364 by Casimir III the Great, the Jagiellonian University is the oldest university in Poland, the second oldest university in Central Europe, and one of the oldest surviving universities in the world. Notable alumni include

astronomer Nicolaus Copernicus, poet Jan Kochanowski, Polish King John III Sobieski, constitutional reformer Hugo Kollataj, chemist Karol Olszewski, anthropologist Bronislaw Malinowski, writer Stanislaw Lem, and President of Poland Andrzej Duda. Students at the University who did not earn diplomas included Nobel laureates Ivo Andrić and Wislawa Szymborska. Pope John Paul II enrolled in the Jagellonian University of Krakow in 1938 to study Polish Studies at the JU Faculty of Philosophy, but shortly after enrollment, his studies were interrupted by Sonderaktion Krakau.

The campus of the Jagiellonian University is centrally located within the city of Kraków. The university consists of fifteen faculties, including the humanities, law, the natural and social sciences, and medicine. The university employs roughly 4,000 academics, and has more than 40,000 students who study in some 80 disciplines.[4] More than half of the student body are women. The language of instruction is usually Polish, although several degrees are offered in either German or English. The university library is one of Poland's largest, and houses several medieval manuscripts, including Copernicus' *De Revolutionibus.*

Copernicus

Among the most famous graduates of the Jagalonian University was Nicolas Copernicus (1473-1543). He was orphaned at the age of ten, but fortunately for science he was adopted by his uncle, Lucas Watzelrode, the Prince-Bishop of Ermland (a small semi-independent state which is now part of Poland). Through his uncle's influence, Copernicus was made a Canon of the Cathedral of Frauenberg in Ermland at the age of twenty-three. He had already spent four years at the University of Krakow, but his first act as Canon was to apply for leave of absence to study in Italy.

At that time, Italy was very much the center of European intellectual activity. Copernicus stayed there for ten years, drawing a comfortable salary from his cathedral, and wandering from one Italian University to another. He studied medicine and church law at Padua and Bologna, and was made a Doctor of Law at the University of Ferrara. Thus, thanks to the influence of his uncle, Copernicus had an education which few men of his time could match. He spent altogether fourteen years as a student at various universities, and he experienced the bracing intellectual atmosphere of Italy at the height of the Renaissance.

In 1506, Bishop Lucas recalled Copernicus to Ermland, where the young Canon spent the next six years as his uncle's personal physician and administrative assistant. After his uncle's death, Copernicus finally took up his duties as Canon at the cathedral-fortress of Frauenberg on the Baltic coast of Ermland; and he remained there for the rest of his life, administering the estates of the cathedral, acting as a physician to the people of Ermland, and working in secret on his sun-centered cosmology.

Even as a student in Krakow, Copernicus had thought about the problem of removing the defects in the Ptolomeic system. In Italy, where the books of the ancient philosophers

Figure 6.14: **Nicolas Copernicus (1473-1543).**

had just become available in the original Greek, Copernicus was able to search among their writings for alternative proposals. In Ptolemy's system, not all the "wheels within wheels" turn with a uniform velocity, although it is possible to find a point of observation called the *"punctum equans"* from which the motion seems to be uniform. Concerning this, Copernicus wrote:

"A system of this sort seems neither sufficiently absolute, nor sufficiently pleasing to the mind... Having become aware of these defects, I often considered whether there could be found a more reasonable arrangement of circles, in which everything would move uniformly about its proper center, as the rule of absolute motion requires.."

While trying to remove what he regarded as a defect in the Ptolemeic system by rearranging the wheels, Copernicus rediscovered the sun-centered cosmology of Aristarchus. However, he took a crucial step which went beyond Aristarchus: What Copernicus did during the thirty-one years which he spent in his isolated outpost on the Baltic was to develop the heliocentric model into a complete system, from which he calculated tables of planetary positions.

The accuracy of Copernicus' tables was a great improvement on those calculated from the Ptolemeic system, and the motions of the planets followed in a much more natural way. The inner planets, Mercury and Venus, stayed close to the sun because of the smallness of their orbits, while the occasional apparently retrograde motion of the outer planets could be explained in a very natural way by the fact that the more rapidly-moving earth sometimes overtook and passed one of the outer planets. Furthermore, the speed of the planets diminished in a perfectly regular way according to their distances from the sun.

According the the Copernican cosmology, the earth moves around the sun in an orbit whose radius is ninety-three million miles. As the earth moves in its enormous orbit, it is sometimes closer to a particular star, and sometimes farther away. Therefore the observed positions of the stars relative to each other ought to change as the earth moves around its orbit. This effect, called "stellar parallax", could not be observed with the instruments

Figure 6.15: **Jagalonian University, Krakow, Poland.**

which were available in the 16th century.

The explanation which Copernicus gave for the absence of stellar parallax was that "Compared to the distance of the fixed stars, the earth's distance from the sun is neglegibly small!" If this is true for the nearest stars, then what about the distance to the farthest stars?

Vast and frightening chasms of infinity seemed to open under the feet of those who understood the implications of the Copernican cosmology. Humans were no longer rulers of a small, tidy universe especially created for themselves. They were suddenly "lost in the stars", drifting on a tiny speck of earth through unimaginably vast depths of space. Hence the cry of Blaise Pascal: *"Le silence eternal de ce éspaces infinis m'effraie!"*, "The eternal silence of these infinite spaces terrifies me!"

Figure 6.16: **Some Jagalonian University buildings.**

6.9 University of Vienna, Austria, 1365

Foundation by Duke Rudolph IV

According to Wikipedia,

The University of Vienna is a public university located in Vienna, Austria. It was founded by Duke Rudolph IV in 1365 and is the oldest university in the German-speaking world. With its long and rich history, the University of Vienna has developed into one of the largest universities in Europe, and also one of the most renowned, especially in the Humanities. It is associated with 20 Nobel prize winners and has been the academic home to many scholars of historical as well as of academic importance.

Sigmund Freud

Freud was one of the most famous alumni of the University of Vienna. He received his medical degree from the university in 1881, and he became a professor there in 1902. Forced to leave Austria to escape from the Nazis, he spent his last years in England.

Nobel laureates

- Robert Bárány Physiology or Medicine 1914
- Richard Adolf Zsigmondy Chemistry 1925
- Julius Wagner-Jauregg Physiology or Medicine 1927
- Hans Fischer Chemistry 1930
- Karl Landsteiner Physiology or Medicine 1930

- Erwin Schrödinger Physics 1933. *What is Life?* That was the title of a small book published by the physicist Erwin Schrödinger in 1944. Schrödinger (1887-1961) was born and educated in Austria. In 1926 he shared the Nobel Prize in Physics[1] for his contributions to quantum theory (wave mechanics). Schrödinger's famous wave equation is as fundamental to modern physics as Newton's equations of motion are to classical physics. When the Nazis entered Austria in 1938, Schrödinger opposed them, at the risk of his life. To escape arrest, he crossed the Alps on foot, arriving in Italy with no possessions except his knapsack and the clothes which he was wearing. He traveled to England; and in 1940 he obtained a position in Ireland as Senior Professor at the Dublin Institute for Advanced Studies. There he gave a series of public lectures upon which his small book is based. In his book, *What is Life?*, Schrödinger developed the idea that a gene is a very large information-containing molecule which might be compared to an aperiodic crystal. He also examined in detail the hypothesis (due to Max Delbrück) that X-ray induced mutations of the type studied by Hermann Muller can be thought of as photo-induced transitions from one isomeric conformation of the genetic molecule to another. Schrödinger's book has great historic importance, because Francis Crick (whose education was in physics) was one of the many people who became interested in biology as a result of reading it. Besides discussing what a gene might be in a way which excited the curiosity and enthusiasm of Crick, Schrödinger devoted a chapter to the relationship between entropy and life.
- Otto Loewi Physiology or Medicine 1936. The first known neurotransmitter molecule, acetylcholine, was discovered jointly by Sir Henry Dale in England and by Otto Loewi in Germany. In 1921 Loewi was able to show that nerve endings transmit information to muscles by means of this substance. The idea for the critical experiment occurred to him in a dream at 3 am. Otto Loewi woke up and wrote down the idea; but in the morning he could not read what he had written. Luckily he had the same dream the following night. This time he took no chances. He got up, drank some coffee, and spent the whole night working in his laboratory. By morning he had shown that nerve cells separated from the muscle of a frog's heart secrete a chemical substance when stimulated, and that this substance is able to cause contractions of the heart of another frog. Sir Henry Dale later showed that Otto Loewi's transmitter molecule was identical to acetylcholine, which Dale had isolated from the ergot fungus in 1910. The two men shared a Nobel Prize in 1936.
- Victor Francis Hess Physics 1936
- Richard Kuhn Chemistry 1938
- Max Perutz Chemistry 1962
- Karl von Frisch Physiology or Medicine 1973. Karl von Frisch, the first of the three ethologists who shared the 1973 prize, is famous for his studies of the waggle-dance of honeybees. Bees guide each other to sources of food by a genetically programmed signaling method - the famous waggle dance, deciphered in 1945 by von Frisch. When

[1] with P.A.M. Dirac

a worker bee has found a promising food source, she returns to the hive and performs a complex dance, the pattern of which indicates both the direction and distance of the food. The dancer moves repeatedly in a pattern resembling the Greek letter Θ. If the food-discoverer is able to perform her dance on a horizontal flat surface in view of the sun, the line in the center of the pattern points in the direction of the food. However, if the dance is performed in the interior of the hive on a vertical surface, gravity takes the place of the sun, and the angle between the central line and the vertical represents the angle between the food source and the sun.

- Konrad Lorenz Physiology or Medicine 1973. The third of the 1973 prizewinners, Konrad Lorenz, is more controversial, but at the same time very interesting in the context of studies of the causes of war and discussions of how war may be avoided. As a young boy, he was very fond of animals, and his tolerant parents allowed him to build up a large menagerie in their house in Altenberg, Austria. Even as a child, he became an expert on waterfowl behavior, and he discovered the phenomenon of imprinting. He was given a one day old duckling, and found, to his intense joy, that it transferred its following response to his person. As Lorenz discovered, young waterfowl have a short period immediately after being hatched, when they identify as their "mother" whomever they see first. In later life, Lorenz continued his studies of imprinting, and there exists a touching photograph of him, with his white beard, standing waist-deep in a pond, surrounded by an adoring group of goslings who believe him to be their mother. Lorenz also studied bonding behavior in waterfowl. It is, however, for his controversial book *On Aggression* that Konrad Lorenz is best known. In this book, Lorenz makes a distinction between intergroup aggression and intragroup aggression. Among animals, he points out, rank-determining fights are seldom fatal. Thus, for example, the fights that determine leadership within a wolf pack end when the loser makes a gesture of submission. By contrast, fights between groups of animals are often fights to the death, examples being wars between ant colonies, or of bees against intruders, or the defense of a rat pack against strange rats. Many animals, humans included, seem willing to kill or be killed in defense of the communities to which they belong. Lorenz calls this behavioral tendency a "communal defense response". He points out that the "holy shiver" - the tingling of the spine that humans experience when performing a heroic act in defense of their communities - is related to the prehuman reflex for raising the hair on the back of an animal as it confronts an enemy - a reflex that makes the animal seem larger than it really is.
- Friedrich Hayek Economics 1974
- Elias Canetti Literature 1981
- Elfriede Jelinek Literature 2004

Figure 6.17: **The University of Vienna, Austria.**

Figure 6.18: **The Faculty of Psychology at the University of Vienna.**

6.10 Ruprecht Karl University of Heidelberg, Germany, 1386

Schism and the foundation of the university

In the Great Schism of 1378, two popes were elected after the death of Pope Gregory XI. One of these popes has his residence in Avignon, France, while the other resided in Rome. Germany's leaders supported the pope in Rome, which meant that German scholars studying at the University of Paris lost their stipends. The German Elector of Palatine, Rupert I, recognized this as an opportunity, and initiated talks with Rome that led to a Papal Bull authorizing the foundation of the University of Heidelberg in 1386.

Nobel prizewinners associated with Heidelberg

Alumni

- Theodor W. Hänsch, Physics, 2005
- Wolfgang Ketterle, Physics, 2001
- Max Born, Physics, 1954
- James Franck, Physics, 1925
- Heike Onnes, Physics, 1913
- Albert Michelson, Physics, 1907
- Philipp Lenard, Physics, 1905
- Stefan Hell, Chemistry, 2014
- Fritz Haber, Chemistry, 1918
- Adolf von Baeyer, Chemistry, 1905
- Hans Spemann, Physiology or Medicine, 1935
- Otto Warburg, Physiology or Medicine, 1931
- Otto Meyerhoff, Physiology or Medicine, 1922
- Carl Spitteler, Literature, 1919
- Charles Gobat, Peace, 1902

Long-term staff

- Hans D, Jensen, Physics, 1963
- Walther Bothe, Physics, 1954
- Philipp Lenard, Physics, 1905
- Georg Wittig, Chemistry, 1979
- Karl Ziegler, Chemistry, 1963
- Richard Kuhn, Chemistry, 1938
- Carl Bosch, Chemistry, 1931
- Friedrich Bergius, Chemistry, 1931
- Bert Sakmann, Physiology or Medicine, 1991
- Albrecht Kossel, Physiology or Medicine, 1910

Figure 6.19: **The University of Heidelberg.**

Other early German universities

- University of Leipzig, 1409
- University of Rostock, 1419
- University of Greifswald, 1456
- Albert Ludwigs University of Freiburg, 1457
- Ludwig Maximilian University of Munich, 1472
- Eberhard Karls University of Tübingen, 1477

Figure 6.20: **Heidelberg, Germany.**

6.11 University of Basel, Switzerland, 1460

The Bernoullis and Euler

Among the most famous graduates of the University of Basel were Danial Bernoulli and Leonhard Euler. Danial Bernoulli was a member of an extraordinary family of mathematicians. They were descended from a wealthy merchant family in Basel, Switzerland. The head of the family, Nicolas Bernoulli the Elder, tried to force his three sons, James (1654-1705), Nicolas II (1662-1716) and John (1667-1748) to follow him in carrying on the family business. However, the eldest son, James, had taught himself the Leibnizian form of calculus, and instead became Professor of Mathematics at the University of Basel. His motto was *"Invicto patre sidera verso"* ("Against my father's will, I study the stars").

Nicolas II and John soon caught their brother's enthusiasm, and they learned calculus from him. John became Professor of Mathematics in Gröningen and Nicolas II joined the faculty of the newly-formed Academy of St. Petersburg. John Bernoulli had three sons, Nicolas III (1695-1726), Daniel (1700-1782) and John II (1710-1790), all of whom made notable contributions to mathematics and physics. In fact, the family of Nicolas Bernoulli the Elder produced a total of nine famous mathematicians in three generations!

Daniel Bernoulli's brilliance made him stand out even among the other members of his gifted family. He became professor of mathematics at the Academy of Sciences in St. Petersburg when he was twenty-five. After eight Russian winters however, he returned to his native Basel. Since the chair in mathematics was already occupied by his father, he was given a vacant chair, first in anatomy, then in botany, and finally in physics. In spite of the variety of his titles, however, Daniel's main work was in applied mathematics, and he has been called the father of mathematical physics.

One of the good friends of Daniel Bernoulli and his brothers was a young man named

Leonhard Euler (1707-1783). He came to their house once a week to take private lessons from their father, John Bernoulli. Euler was destined to become the most prolific mathematician in history, and the Bernoullis were quick to recognize his great ability. They persuaded Euler's father not to force him into a theological career, but instead to allow him to go with Nicolas III and Daniel to work at the Academy in St. Petersburg.

Euler married the daughter of a Swiss painter and settled down to a life of quiet work, producing a large family and an unparalleled output of papers. A recent edition of Euler's works contains 70 quarto volumes of published research and 14 volumes of manuscripts and letters. His books and papers are mainly devoted to algebra, the theory of numbers, analysis, mechanics, optics, the calculus of variations (invented by Euler), geometry, trigonometry and astronomy; but they also include contributions to shipbuilding science, architecture, philosophy and musical theory!

Euler achieved this enormous output by means of a calm and happy disposition, an extraordinary memory and remarkable powers of concentration, which allowed him to work even in the midst of the noise of his large family. His friend Thiébault described Euler as sitting "..with a cat on his shoulder and a child on his knee - that was how he wrote his immortal works".

In 1771, Euler became totally blind. Nevertheless, aided by his sons and his devoted scientific assistants, he continued to produce work of fundamental importance. It was his habit to make calculations with chalk on a board for the benefit of his assistants, although he himself could not see what he was writing. Appropriately, Euler was making such computations on the day of his death. On September 18, 1783, Euler gave a mathematics lesson to one of his grandchildren, and made some calculations on the motions of balloons. He then spent the afternoon discussing the newly-discovered planet Uranus with two of his assistants. At five o'clock, he suffered a cerebral hemorrhage, lost consciousness, and died soon afterwards. As one of his biographers put it, "The chalk fell from his hand; Euler ceased to calculate, and to live".

In the eighteenth century it was customary for the French Academy of Sciences to propose a mathematical topic each year, and to award a prize for the best paper dealing with the problem. Léonard Euler and Daniel Bernoulli each won the Paris prize more than ten times, and they share the distinction of being the only men ever to do so. John Bernoulli is said to have thrown his son out of the house for winning the Paris prize in a year when he himself had competed for it.

Euler and the Bernoullis did more than anyone else to develop the Leibnizian form of calculus into a workable tool and to spread it throughout Europe. They applied it to a great variety of problems, from the shape of ships' sails to the kinetic theory of gasses. An example of the sort of problem which they considered is the vibrating string.

In 1727, John Bernoulli in Basle, corresponding with his son Daniel in St. Petersburg, developed an approximate set of equations for the motion of a vibrating string by considering it to be a row of point masses, joined together by weightless springs. Then Daniel boldly passed over to the continuum limit, where the masses became infinitely numerous and small.

The result was Daniel Bernoulli's famous wave equation, which is what we would now

Figure 6.21: **Students from the University of Basel, Switzerland.**

call a partial differential equation. He showed that the wave equation has sinusoidal solutions, and that the sum of any two solutions is also a solution. This last result, his superposition principle, is a mathematical proof of a property of wave motion noticed by Huygens. The fact that many waves can propagate simultaneously through the same medium without interacting was one of the reasons for Huygens' belief that light is wave-like, since he knew that many rays of light from various directions can cross a given space simultaneously without interacting. Because of their work with partial differential equations, Daniel Bernoulli and Léonard Euler are considered to be the founders of modern theoretical physics.

Other famous graduates

Other famous graduates of the University of Basel include Erasmus of Rotterdam, Paracelcus, Jacob Burckhardt, Friedrich Nietzsche, Tadeusz Reichstein, Karl Jaspers, Carl Gustav Jung, Karl Barth, and Jeanne Hersch.

Figure 6.22: **The University of Basel.**

6.12 University of Uppsala, Sweden, 1477

Linnaeus

During the 17th and 18th centuries, naturalists had been gathering information on thousands of species of plants and animals. This huge, undigested heap of information was put into some order by the great Swedish naturalist, Carl von Linné (1707-1778), who is usually called by his Latin name, Carolus Linnaeus.

Linnaeus was the son of a Swedish pastor. Even as a young boy, he was fond of botany, and after medical studies at Lund, he became a lecturer in botany at the University of Uppsala, near Stockholm. In 1732, the 25-year-old Linnaeus was asked by his university to visit Lapland to study the plants in that remote northern region of Sweden.

Linnaeus travelled four thousand six hundred miles in Lapland, and he discovered more than a hundred new plant species. In 1735, he published his famous book, *Systema Naturae*, in which he introduced a method for the classification of all living things.

Linnaeus not only arranged closely related species into genera, but he also grouped related genera into classes, and related classes into orders. (Later the French naturalist Cuvier (1769-1832) extended this system by grouping related orders into phyla.) Linnaeus introduced the binomial nomenclature, still used today, in which each plant or animal is given a name whose second part denotes the species while the first part denotes the genus.

Linnaeus proposed three kingdoms, which were divided into classes. From classes, the groups were further divided into orders, families, genera (singular: genus), and species. An additional rank beneath species distinguished between highly similar organisms. While his system of classifying minerals has been discarded, a modified version of the Linnaean classification system is still used to identify and categorize animals and plants.

Figure 6.23: **University of Uppsala, the Gustavanium.**

Figure 6.24: **University of Uppsala, the Linnaeus Botanical Garden.**

6.13 University of Copenhagen, Denmark, 1479

Bohr's Institute of Theoretical Physics

In 1916, Niels Bohr, famous for pioneering the quantum theory of atoms and molecules, was appointed professor of theoretical physics at the University of Copenhagen, a post that had been created especially for him. The following year, in 1917, he started to raise money for the construction of a new institute in which his new department could be housed. The project received large contributions from the Danish government and the Carlsberg Foundation, and from wealthy Danish businessmen. Bohr himself designed the building, which opened in 1920.

During the period when Hitler's Nazi party was coming to power in Germany, Bohr was able to offer a refuge at his Institute of Theoretical Physics to many important physicists who could no longer remain in Germany. Those to whom Bohr gave refuge included Guido Beck, Felix Bloch, James Franck, George de Hevesy, Otto Frisch, Hilde Levi, Lise Meitner, George Placzek, Eugene Rabinowitch, Stefan Rozental, Erich Ernst Schneider, Edward Teller, Arthur von Hippel and Victor Weisskopf. Because of this, because of Bohr's dynamic and inspiring presence, and because he was able to continue the tradition of informality, enthusiasm and speed which characterized J.J. Thomson's Cavendish and Rutherford's Manchester laboratories, Bohr's institute became the world's most important center for theoretical physics, especially during the 1930's.

Bohr was tirelessly energetic. He liked to discuss his ideas in dialogue with one of the bright young men at his institute, putting forward an idea, and expecting a counter-argument to be thrown back. It was like a game of ping-pong. In this way, a new idea could be tested by exploring all of its consequences.

When a new scientist arrived at his institute, Bohr liked to invite the newcomer to accompany him on a two-day walking tour to his summer house in Tisvilde, about 50 kilometers north of Copenhagen. In his autobiographical book "Physics and Beyond", Werner Heisenberg describes such a two-man tour together with Bohr. This custom allowed Bohr to get to know both the personality and the potential scientific contributions of the new arrival. It also allowed Bohr to get some exercise and to keep himself in good physical condition.

Nobel laureates associated with the University of Copenhagen

Alumni

- Subrahmanyan Chandrasekhar, Physics, 1983
- Steven Weinberg, Physics, 1979
- Aage Bohr, Physics, 1975
- Niels Bohr, Physics, 1922
- Jens Skou, Chemistry, 1997
- Niels Jerne, Physiology or Medicine, 1984
- Henrik Dam, Physiology or Medicine, 1943

- Johannes Fibiger, Physiology or Medicine, 1926
- August Krogh, Physiology or Medicine, 1920
- Niels Finsen, Physiology or Medicine, 1903
- Johannes V. Jensen, Literature, 1944
- Karl Adolph Gjellerup, Literature, 1917

Long-term academic staff

- Aage Bohr, Physics, 1975
- Werner Heisenberg, Physics, 1932
- Niels Bohr, Physics, 1922
- George de Hevesy, Chemistry, 1943
- Henrik Dam, Physiology or Medicine, 1943
- Johannes Fibiger, Physiology or Medicine, 1926
- August Krogh, Physiology or Medicine, 1920
- Bertil Ohlin, Economics, 1977

Short-term academic staff

- Andre Geim, Physics, 2010
- David Gross, Physics, 2004
- Sheldon Glashow, Physics, 1979
- Neville Mott, Physics, 1977
- Ben Mottelson, Physics, 1975
- John Schrieffer, Physics, 1972
- Hans Bethe, Physics, 1967
- Lev Landau, Physics, 1962
- Donald Glaser, Physics, 1960
- Felex Bloch, Physics, 1952
- Wolfgang Pauli, Physics, 1945
- Isador Rabi. Physics, 1944
- Paul Dirac, Physics, 1933
- Werner Heisenberg, Physics, 1932
- James Franck, Physics, 1925
- Walter Kohn, Chemistry, 1998
- Paul Berg, Chemistry, Chemistry, 1980
- Geoffrey Wilkinson, Chemistry, 1973
- Linus Pauling, Chemistry, 1954
- Harold Urey, Chemistry, 1934
- Edward B. Lewis, Physiology or Medicine, 1995
- Max Delbrück, Physiology or Medicine, 1969
- James Watson. Physiology or Medicine, 1962
- Wiliam Nordhaus, Economics, 2018
- Laurence Klein, Economics, 1980

Figure 6.25: **University of Copenhagen buildings at Frue Plads.**

Figure 6.26: **Niels Bohr and Albert Einstein.**

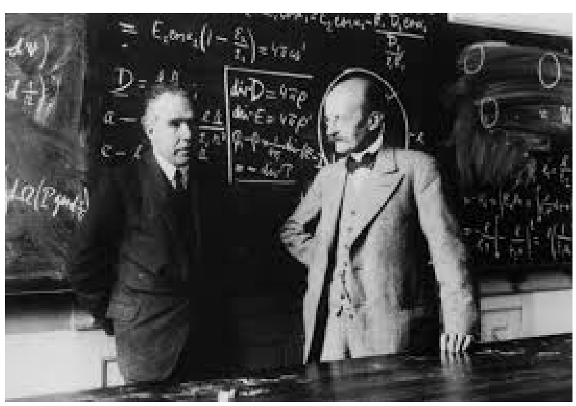

Figure 6.27: **Niels Bohr and Max Planck.**

List of the 100 highest ranked universities today

1. Massachusetts Institute of Technology (MIT)
2. Stanford University
3. Harvard University
4. University of Oxford
5. California Institute of Technology (Caltech)
6. ETH Zurich - Swiss Federal Institute of Technology
7. University of Cambridge
8. UCL (University College London)
9. Imperial College London
10. University of Chicago
11. National University of Singapore (NUS)
12. Nanyang Technological University, Singapore (NTU)
13. Princeton University
14. Cornell University
15. University of Pennsylvania
16. Tsinghua University, China
17. Yale University
18. Columbia University
19. EPFL - Ecole Polytechnique Federale de Lausanne, Switzerland
20. University of Edinburgh
21. University of Michigan
22. Peking University, China
23. University of Tokyo
24. Johns Hopkins University
25. University of Hong Kong
26. Duke University
27. University of Manchester
28. University of California, Berkeley (UCB)
29. Australian National University
30. University of Toronto, Canada
31. Northwestern University
32. Hong Kong University of Science and Technology
33. King's College London
34. Kyoto University
35. McGill University, Canada
36. University of California, Los Angeles (UCLA)
37. Seoul National University, South Korea
38. University of Melbourne, Australia
39. New York University (NYU)
40. Fudan University, China
41. KAIST - Korea Advanced Institute of Science & Technology, South Korea

42. University of Sydney, Australia
43. University of New South Wales (UNSW Sydney), Australia
44. London School of Economics and Political Science (LSE)
45. University of California, San Diego (UCSD)
46. Chinese University of Hong Kong (CUHK)
47. University of Queensland, Australia
48. Carnegie Mellon University, United States
49. University of Bristol, United Kingdom
50. Delft University of Technology, Netherlands
51. University of British Columbia, Canada
52. City University of Hong Kong
53. Université PSL, France
54. Zhejiang University, China
55. Technical University of Munich, Germany
56. University of Wisconsin - Madison, United States
57. Brown University, United States
58. Tokyo Institute of Technology, Japan
59. Monash University, Australia
60. Shanghai Jiao Tong University, China
61. Ecole Polytechnique, France
62. University of Warwick, United Kingdom
63. Ludwig-Maximilians-Universität München, Germany
64. University of Amsterdam, Netherlands
65. University of Texas at Austin, United States
66. Ruprecht-Karls-Universität Heidelberg, Germany
67. University of Glasgow, United Kingdom
68. University of Washington, United States
69. National Taiwan University (NTU), Taiwan
70. Universiti Malaya (UM), Malaya
71. Osaka Univesity, Japan
72. Georgia Institute of Technology, United States
73. University of Copenhagen, Denmark
74. Universidad de Buenos Aires (UBA), Argentina
75. University of Illinois at Urbana-Champaign, United States
76. University of Zurich, Switzerland
77. Sorbonne University, France
78. Durham University, United Kingdom
79. University of Sheffield, United Kingdom
80. KU Leuven, Belgium
81. University of Birmingham, United Kingdom
82. Tohoku University, Japan
83. Korea University, South Korea
84. Lomonosov Moscow State University, Russia

85. Rice University, United States
86. University of Western Australia, Australia
87. Pohang University of Science and Technology (POSTECH), South Korea
88. University of Auckland, New Zealand
89. University of Science and Technology of China, China
90. University of North Carolina, Chapel Hill, United Stated
91. Hong Kong Polytechnic University, Hong Kong
92. Lund University, Sweden
93. Pennsylvania State University, United States
94. University of Leeds, United Kingdom
95. Sungkyunkwan University (SKKU), South Korea
96. University of Nottingham, United Kingdom
97. University of Southampton, United Kingdom
98. Boston University, United States
99. KTH Royal Institute of Technology, Sweden
100. University of St Andrews, United Kingdom

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Chapter 7

WOMEN'S EDUCATION

7.1 Woman's rights and population stabilization

Experts agree that higher status for women. higher education for women, and jobs outside the home are key steps that are needed to stabilize global population. Moreover, these reforms are highly desirable for their own sake, for the sake of justice and equality, and for the sake of the uniquely life-oriented vision that women can give us.

In this chapter, we review some of the historical steps in this direction, staring with Mary Wollstonecraft's book *Vindication of the Rights of Woman*, published in 1792.

Mary Wollstonecraft

The first of a new genus

Mary Wollstonecraft was born in London 1n 1759. Although her family had a comfortable income during her childhood, Mary's father later lost his fortune through speculation, and the family entered a period of severe financial difficulties. He also subjected his wife to physical violence, and Mary often slept in front of her mother's door in order to protect her.

Because of the family's financial problems, Mary was forced to take a number of jobs which she found very distasteful, for example as companion to an unpleasant old lady. However, while working, she tried her hand as a writer, producing a children's book, *Original Stories From Real Life* (1788), and two pioneering feminist books, *Thoughts on the Education of Daughters* and *Mary: A Fiction* (1788).

Mary Wollstonecraft then bravely decided to try to support herself through writing. As she wrote to her sister, had decided to become the first of a new genus: a professional female writer. Having learned French and German, she translated Necker's *Of the Importance of Religious Opinions* and Saltzman's *Elements of Morality for the Use of Children*. Mary was helped in her new career by the liberal publisher, Joseph Johnson, who was also the publisher of Thomas Paine and William Godwin. Mary met these already famous authors at Johnson's dinner parties, and conversations with them helped to expand her knowledge

Figure 7.1: **Mary Wollstonecraft in a painting by John Opie (public domain).**

and ambitions. Joseph Johnson was a very brave man. By publishing the works of radical authors, he was risking arrest by England's repressive government. In her letters, Mary described Johnson as "a father and brother".

Scandalous love affairs

Mary Wollstonecraft had two scandalous love affairs. At that time, according to the strict rules for female behavior, these placed her completely outside the bounds of society.

The first of these unconventional love affairs was with the already married artist Henry Fuseli. Mary proposed to Fuseli's wife that all three of them should live together, but (not surprisingly) Fuseli's wife rejected this plan in horror and forced her husband to break off the relationship with Mary.

Mary then decided to travel to France, where the French Revolution had just taken place. She arrived there in 1792, about a month before the execution of Louis XVI. There she fell passionately in love with an American adventurer, Gilbert Imlay, with whom she had a daughter named Fanny. When Britain declared war on France in 1794, Imlay registered Mary as his wife in order to protect her from the French authorities, even though they were not married.

Vindication of the Rights of Woman

While in France, Mary Wollstonecraft had written *An Historical and Moral View of the French Revolution*, which was published in London in 1794. She also wrote *Vindication of the Rights of Woman* (1792) and *Vindication of the Rights of Man* (1792). Both of these were replies to Edmund Burke's argument for conservatism, *Reflection on the Revolution in France*. In her book on the rights of women, Mary wrote:

"My main argument is built on this simple principle, that if [woman] be not prepared by education to become the companion of man, she will stop the progress of knowledge and virtue; for truth must be common to all",

Wollstonecraft contends that society will degenerate without educated women, particularly because mothers are the primary educators of young children. She attributes the problem of uneducated women to men and

"...a false system of education, gathered from the books written on this subject by men who [consider] females rather as women than human creatures"

"Taught from their infancy that beauty is woman's sceptre, the mind shapes itself to the body, and, roaming round its gilt cage, only seeks to adorn its prison"

"I then would fain convince reasonable men of the importance of some of my remarks; and prevail on them to weigh dispassionately the whole tenor of my observations. I appeal to their understandings; and, as a fellow-creature, claim, in the name of my sex, some interest in their hearts. I entreat them to assist to emancipate their companion, to make her a help meet for them! Would men but generously snap our chains, and be content with rational fellowship instead of slavish obedience, they would find us more observant daughters, more affectionate sisters, more faithful wives, more reasonable mothers: in a word, better citizens. ”

Return to England and marriage to William Godwin

When France became too dangerous, Imlay had traveled to London, and Mary joined him there in 1794, hoping to continue their relationship. When he rejected her, she attempted suicide. In another attempt to win Imlay’s affections. Mary traveled to Norway to take care of Imlay’s business dealings there. But when she returned to London, Imlay once again rejected her, and she once again attempted suicide. Once again was saved, this time by someone who saw her leap from a bridge into the Thames.

Gradually recognizing that her pursuit of Imlay was hopeless, Mary resumed her writing career, encouraged, as before by by the brave publisher Joseph Johnson. At Johnson’s parties she once again met the famous novelist and philosopher William Godwin. This time, they both formed a higher opinion of each other than at their first meeting. A passionate love affair developed between them, and when Mary became pregnant, they were married. Tragically, Mary Wollstonecraft died in childbirth. Her daughter with William Godwin would later become the wife of Godwin’s admirer, the poet Percy Bysshe Shelley. Mary Shelley continued the family tradition by becoming a famous author: She created the masterpiece *Frankenstein*.

7.2 Educational equality for women

Maria Montessori and modern educational methods

Dr. Maria Montessori (1870-1952) was an Italian physician and educator who pioneered modern non-authoritarian methods of education. Her father was an official in the Italian Ministry of Finance, while her mother belonged to a family that greatly valued education. Encouraged by her mother, the young Maria first studied to become an engineer, at that time an unusual profession for a woman, and then changed to the even more unusual study of medicine.

After passing examinations in botany, zoology, experimental physics, histology, anatomy, and general and organic chemistry at the University of Rome, she was finally accepted as a medical student. Because she was a woman, Montessori encountered discrimination and opposition from both the students and staff of Rome’s medical school. She was forced to perform anatomy dissections alone at night, because it was considered improper for a woman to view naked bodies in the company of men. Nevertheless, Maria Montessori graduated with distinction, having specialized in pediatrics and psychology during her last two years.

Dr. Montessori then became interested in the problem of educating retarded children. The experimental methods which she introduced were built on the natural tendencies of

Figure 7.2: **Dr. Maria Montessori (1870-1952).**

all children to explore their environments and to learn new skills. She gave her students the materials that they needed to be creative, and let them use these materials in their own spontaneous way. Her results were astonishingly successful, and most of her students, despite having been classified as retarded, were able to pass normal examinations. Encouraged by this success, Montessori tried the same methods on normal students. Again the results were remarkable. The normal children became super-good students. Her astonishingly good results made Maria Montessori internationally famous. She later studied anthropology and added this discipline to medicine, pediatrics and psychology as a background for her educational work.

Some quotations from Dr. Maria Montessori's many books

"And so we discovered that education is not something which the teacher does, but that it is a natural process which develops spontaneously in the human being. It is not acquired by listening to words, but in virtue of experiences in which the child acts on his environment. The teacher's task is not to talk, but to prepare and arrange a series of motives for cultural activity in a special environment made for the child" (from *The Absorbent Mind*).

"..the task of the educator lies in seeing that the child does not confound good with immobility, and evil with activity, as often happens in old-time discipline... A room in which all the children move about usefully, intelligently, and voluntarily, without committing any rough or rude act, would seem to me a classroom very well disciplined indeed." (from *The Montessori Method*)

"The instructions of the teacher consist then merely in a hint, a touch - enough to give a start to the child. The rest develops of itself." (from *Dr. Montessori's Own Handbook*)

"Today, however, those things which occupy us in the field of education are the interests of humanity at large and of civilization, and before such great forces we can recognize only one country - the entire world."(from *The Montessori Method*)

"How can we speak of Democracy or Freedom when from the very beginning of life we mould the child to undergo tyranny, to obey a dictator? How can we expect democracy when we have reared slaves? Real freedom begins at the beginning of life, not at the adult stage. These people who have been diminished in their powers, made short-sighted, devitalized by mental fatigue, whose bodies have become distorted, whose wills have been broken by elders who say: 'your will must disappear and mine prevail!' - how can we expect them, when school-life is finished, to accept and use the rights of freedom?" (from *Education for a New World*)

"Nowadays nobody's life is safe. An absurd war may be declared in which all men - young and old, women and children - are in mortal danger. Civilians are bombed and people have to take refuge in underground shelters just as primitive men took refuge in caves to defend themselves against wild beasts. The supply of food may be cut off and millions may die of famine and plague. Do we not see men in rags or even naked, freezing to death, families separated and torn apart, children abandoned and roaming about in wild hordes?

"This we see, not only among those vanquished in war, but everywhere. Humanity itself is vanquished and enslaved - but why enslaved? Because all men are slaves, the victors as well as the vanquished, insecure, frightened, suspicious and hostile, compelled to defend themselves by means of spying and brigandage, using and fostering immorality as a means of defense..."

"It may seem that we have drifted rather far from our original subject - Education. This digression, however, must open up the new road along which we now have to go. In the same way in which we help the patients in a hospital to recover their health and continue to live so we must now help humanity to save itself. We must be nurses in a hospital, as vast as the world itself." (from *The Formation of Man*).

7.3 Malala Yousafzai

Malala Yousafzai was born in 1997 in the beautiful Swat Valley of Pakistan. Her father, Ziauddin Yousafzai is a poet, educational activist, and school owner. In 2008, he was contacted by a representative of the BBC's Urdu service and asked to recommend a girl from one of his schools to write a continuing blog about what life was like under the Taliban. When all of the girls whom Ziauddin asked were too frightened, he finally recommended his own daughter, Malala. Her blog was aired anonymously by the BBC Urdu service.

After the BBC diary ended, Malala Yousafzai and her father were approached by a New York Times reporter about filming a documentary. Wikipedia states that "Following the documentary, Yousafzai was interviewed on the national Pashto-language station AVT Khyber, the Urdu-language Daily Aaj, and Canada's Toronto Star.[34] She made a second appearance on Capital Talk on 19 August 2009. Her BBC blogging identity was being revealed in articles by December 2009. She also began appearing on television to publicly advocate for female education. From 2009 to 2010 she was the chair of the District Child Assembly of the Khpal Kor Foundation through 2009 and 2010."

"In October 2011, Archbishop Desmond Tutu, a South African activist, nominated Yousafzai for the International Children's Peace Prize of the Dutch international children's advocacy group KidsRights Foundation. She was the first Pakistani girl to be nominated for the award. The announcement said, 'Malala dared to stand up for herself and other girls and used national and international media to let the world know girls should also have the right to go to school.' The award was won by Michaela Mycroft of South Africa.

"Her public profile rose even further when she was awarded Pakistan's first National Youth Peace Prize two months later in December. On 19 December 2011, Prime Minister Yousaf Raza Gillani awarded her the National Peace Award for Youth. At the proceedings in her honor, Yousafzai stated that she was not a member of any political party, but hoped to found a national party of her own to promote education. The prime minister directed the authorities to set up an IT campus in the Swat Degree College for Women at

Yousafzai's request, and a secondary school was renamed in her honor. By 2012, Yousafzai was planning to organize the Malala Education Foundation, which would help poor girls go to school

"As Yousafzai became more recognized, the dangers facing her increased. Death threats against her were published in newspapers and slipped under her door. On Facebook, where she was an active user, she began to receive threats and fake profiles were created under her name. Eventually, a Taliban spokesman said they were 'forced' to act. In a meeting held in the summer of 2012, Taliban leaders unanimously agreed to kill her.

"On 9 October 2012, a Taliban gunman shot Yousafzai as she rode home on a bus after taking an exam in Pakistan's Swat Valley. Yousafzai was 15 years old at the time. According to reports, a masked gunman shouted "Which one of you is Malala? Speak up, otherwise I will shoot you all", and, on upon her being identified, shot her. She was hit with one bullet, which went through her head, neck, and ended in her shoulder. Two other girls were also wounded in the shooting."

Malala did not die, however. The shooting resulted in an enormous international wave of sympathy for her, and outrage at Taliban's murder attempt. She became the world's most famous teenager. She met Queen Elizabeth II and Barack Obama, and spoke at the Oxford Union. Harvard University and the Canadian Parliament. In 2014, she shared the Nobel Peace Prize with Kailash Satyarthi, a children's rights activist from India. Here are some excerpts from her Nobel Address:

"We had a thirst for education, we had a thirst for education because our future was right there in that classroom. We would sit and learn and read together. We loved to wear neat and tidy school uniforms and we would sit there with big dreams in our eyes. We wanted to make our parents proud and prove that we could also excel in our studies and achieve those goals, which some people think only boys can.

"But things did not remain the same. When I was in Swat, which was a place of tourism and beauty, suddenly it changed into a place of terrorism. I was just ten when more than 400 schools were destroyed. Women were flogged. People were killed. And our beautiful dreams turned into nightmares.

"Education went from being a right to being a crime. Girls were stopped from going to school. When my world suddenly changed, my priorities changed too. I had two options. One was to remain silent and wait to be killed. And the second was to speak up and then be killed. I chose the second one. I decided to speak up.

"We could not just stand by and see those injustices of the terrorists denying our rights, ruthlessly killing people and misusing the name of Islam. We decided to raise our voice and tell them: Have you not learnt, have you not learnt that in the Holy Quran Allah says: if you kill one person it is as if you kill the whole humanity?

"...I tell my story, not because it is unique, but because it is not. It is the story of many girls. Today, I tell their stories too. I have brought with me some of my sisters from Pakistan, from Nigeria and from Syria, who share this story. My brave sisters Shazia and Kainat who were also shot that day on our school bus. But they have not stopped learning. And my brave sister Kainat Soomro who went through severe abuse and extreme violence, even her brother was killed, but she did not succumb.

"Also my sisters here, whom I have met during my Malala Fund campaign. My 16-year-old courageous sister, Mezon from Syria, who now lives in Jordan as refugee and goes from tent to tent encouraging girls and boys to learn. And my sister Amina, from the North of Nigeria, where Boko Haram threatens, and stops girls and even kidnaps girls, just for wanting to go to school.

"I am Malala. But I am also Shazia. I am Kainat. I am Kainat Soomro. I am Mezon. I am Amina. I am those 66 million girls who are deprived of education. And today I am not raising my voice, it is the voice of those 66 million girls.

"...Dear sisters and brothers, today, in half of the world, we see rapid progress and development. However, there are many countries where millions still suffer from the very old problems of war, poverty, and injustice.

"We still see conflicts in which innocent people lose their lives and children become orphans. We see many people becoming refugees in Syria, Gaza and Iraq. In Afghanistan, we see families being killed in suicide attacks and bomb blasts.

"Many children in Africa do not have access to education because of poverty. And as I said, we still see, we still see girls who have no freedom to go to school in the north of Nigeria.

"Many children in countries like Pakistan and India, as Kailash Satyarthi mentioned, many children, especially in India and Pakistan are deprived of their right to education because of social taboos, or they have been forced into child marriage or into child labor.

"...Dear sisters and brothers, dear fellow children, we must work - not wait. Not just the politicians and the world leaders, we all need to contribute. Me. You. We. It is our duty.

"Let us become the first generation to decide to be the last , let us become the first generation that decides to be the last that sees empty classrooms, lost childhoods, and wasted potentials. Let this be the last time that a girl or a boy spends their childhood in a factory. Let this be the last time that a girl is forced into early child marriage. Let this be the last time that a child loses life in war. Let this be the last time that we see a child out of school. Let this end with us. Let's begin this ending ... together ... today ... right here, right now. Let's begin this ending now."

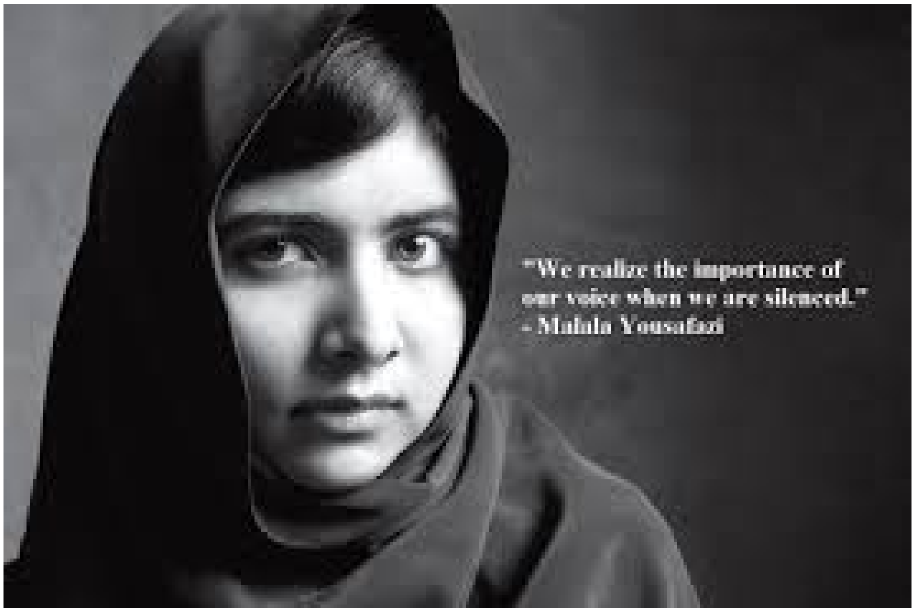

Figure 7.3: **Malala Yousafzai: "We realize the importance of our voice when we are silenced".**

Figure 7.4: **Women are the intellectual equals of men.**

Figure 7.5: **When he was Sweden's Prime Minister, Olof Palme declared that his administration's goal was that "neither in education, nor in opportunities for employment, nor in law, nor in social custom, should there be any difference whatever between men and women".**

Figure 7.6: **Experts agree that educational and legal equality for women are vitally important steps towards stabilizing, and ultimately reducing, global population. These reforms are also extremely important for their own sake, and for the sake of the uniquely life-oriented insights that women can give to the world.**


RIGHT
TO
EDUCATION


गणित


Educated Girls
Educated Society
Develped Nation
Strong Base School
Without Education
51% Of Population
the Country Cannot
Progress
Strong Base School

Suggestions for further reading

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Chapter 8

THE BATTLE AGAINST ILLITERACY

8.1 The invention of writing

Because writing, paper and literacy have not always been widely available, information has traditionally been passed on from one generation to the next by means of recitation and song. Rhythm, rhyme and alliteration are aids to memory, and increase the impact and appeal of a recitation or song. Histories, law and religions have all been been propagated through oral traditions, and in many cultures, these traditions still live today.

However, with the key inventions if writing, paper and printing, the information explosion that characterizes our modern society began in earnest. We shall begin our discussion of literacy and illiteracy by reviewing the history of these key inventions.

Mesopotamia

In Mesopotamia (which in Greek means "between the rivers"), the settled agricultural people of the Tigris and Euphrates valleys evolved a form of writing. Among the earliest Mesopotamian writings are a set of clay tablets found at Tepe Yahya in southern Iran, the site of an ancient Elamite trading community halfway between Mesopotamia and India.

The Elamite trade supplied the Sumarian civilization of Mesopotamia with silver, copper, tin, lead, precious gems, horses, timber, obsidian, alabaster and soapstone. The practical Sumerians and Elamites probably invented writing as a means of keeping accounts.

The tablets found at Tepe Yahya are inscribed in proto-Elamite, and radio-carbon dating of organic remains associated with the tablets shows them to be from about 3,600 B.C.. The inscriptions on these tablets were made by pressing the blunt and sharp ends of a stylus into soft clay. Similar tablets have been found at the Sumerian city of Susa at the head of the Tigris River.

In about 3,100 B.C. the cuneiform script was developed, and later Mesopotamian tablets

Figure 8.1: **Sumerian writing**

are written in cuneiform, which is a phonetic script where the symbols stand for syllables.

Egypt

The Egyptian hieroglyphic (priest writing) system began its development in about 4,000 B.C.. At that time, it was pictorial rather than phonetic. However, the Egyptians were in contact with the Sumerian civilization of Mesopotamia, and when the Sumerians developed a phonetic system of writing in about 3,100 B.C., the Egyptians were quick to adopt the idea. In the cuneiform writing of the Sumerians, a character stood for a syllable. In the Egyptian adaptation of this idea, most of the symbols stood for combinations of two consonants, and there were no symbols for vowels. However, a few symbols were purely alphabetic, i.e. they stood for sounds which we would now represent by a single letter. This was important from the standpoint of cultural history, since it suggested to the Phoenicians the idea of an alphabet of the modern type.

In Sumer, the pictorial quality of the symbols was lost at a very early stage, so that in the cuneiform script the symbols are completely abstract. By contrast, the Egyptian system of writing was designed to decorate monuments and to be impressive even to an illiterate viewer; and this purpose was best served by retaining the elaborate pictographic form of the symbols.

Figure 8.2: **The Phoenician alphabet**

Figure 8.3: **Hieroglyphics**

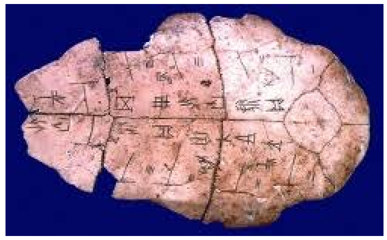

Figure 8.4: **Very early Chinese writing on a bone**

China

Writing was developed at a very early stage in Chinese history, but the system remained a pictographic system, with a different character for each word. A phonetic system of writing was never developed.

The failure to develop a phonetic system of writing had its roots in the Chinese imperial system of government. The Chinese empire formed a vast area in which many different languages were spoken. It was necessary to have a universal language of some kind in order to govern such an empire. The Chinese written language solved this problem admirably.

Suppose that the emperor sent identical letters to two officials in different districts. Reading the letters aloud, the officials might use entirely different words, although the characters in the letters were the same. Thus the Chinese written language was a sort of "Esperanto" which allowed communication between various language groups, and its usefulness as such prevented its replacement by a phonetic system.

The disadvantages of the Chinese system of writing were twofold: First, it was difficult to learn to read and write; and therefore literacy was confined to a small social class whose members could afford a prolonged education. The system of civil-service examinations made participation in the government dependant on a high degree of literacy; and hence the old, established scholar-gentry families maintained a long-term monopoly on power, wealth and education. Social mobility was possible in theory, since the civil service examinations were open to all, but in practice, it was nearly unattainable.

The second great disadvantage of the Chinese system of writing was that it was unsuitable for printing with movable type. An "information explosion" occurred in the west following the introduction of printing with movable type, but this never occurred in China. It is ironical that although both paper and printing were invented by the Chinese, the full effect of these immensely important inventions bypassed China and instead revolutionized the west.

The Americas

The Mayan system of writing is thought to have been invented in about 700 B.C., and this invention is believed to be entirely independent of the invention of writing elsewhere. Some of the Mayan glyphs represented entire words, but the could also represent syllables.

Figure 8.5: **Chinese writing in a later form**

Figure 8.6: **Mayan writing.**

Knotted string systems of keeping records were used by the Andean peoples of South America, especially by the Inca civilization. In the Incan language collections of knotted strings were known as *quipus* or talking knots. Quipus could have only a few, or as many as 2000 knotted strings.

Belts made from shell beads (*wampum*) were used by the natives peoples of North America, both as currency and as a means of recording events.

8.2 The invention of paper

The ancient Egyptians were the first to make books. As early as 4,000 B.C., they began to make books in the form of scrolls by cutting papyrus reeds into thin strips and pasting them into sheets of double thickness. The sheets were glued together end to end, so that they formed a long roll. The rolls were sometimes very long indeed. For example, one roll, which is now in the British Museum, is 17 inches wide and 135 feet long.

(Paper of the type which we use today was not invented until 105 A.D.. This enormously important invention was made by a Chinese eunuch named Tsai Lun. The kind of paper invented by Tsai Lun could be made from many things: for example, bark, wood, hemp, rags, etc.. The starting material was made into a pulp, mixed together with water and binder, spread out on a cloth to partially dry, and finally heated and pressed into thin sheets. The art of paper-making spread slowly westward from China, reaching Baghdad in 800 A.D.. It was brought to Europe by the crusaders returning from the Middle East. Thus paper reached Europe just in time to join with Gütenberg's printing press to form the basis for the information explosion which has had such a decisive effect on human history.)

Many centers of paper production were established throughout the Muslim world, and their techniques were eventually transmitted to Christian Europe. Not only was paper convenient to use, transport, and store, it was, most importantly, considerably cheaper than papyrus and parchment, probably partly because of the use of recycled rags as raw material in its manufacture. Whereas an early Qur'an copy on parchment is reckoned to have required the skins of about 300 sheep, an equivalent amount of paper could be produced much more rapidly, in much greater quantities, and at much lower cost. This transformed the economics of book production, and made possible a greatly increased production of manuscript books, on a scale which was unprecedented and unmatched in Europe at that time.

The career of Leonardo da Vinci illustrates the first phase of the "information explosion" which has produced the modern world: During Leonardo's lifetime, inexpensive paper was being manufactured in Europe, and it formed the medium for Leonardo's thousands of pages of notes. His notes and sketches would never have been possible if he had been forced to use expensive parchment as a medium. On the other hand, the full force of Leonardo's genius and diligence was never felt because his notes were not printed.

Copernicus, who was a younger contemporary of Leonardo, had a much greater effect on the history of ideas, because his work was published. Thus, while paper alone made a large contribution to the information explosion, it was printing combined with paper which had an absolutely decisive and revolutionary impact: The modern scientific era began with the introduction of printing.

Figure 8.7: **Papyrus**

Figure 8.8: **Paper is a Chinese invention**

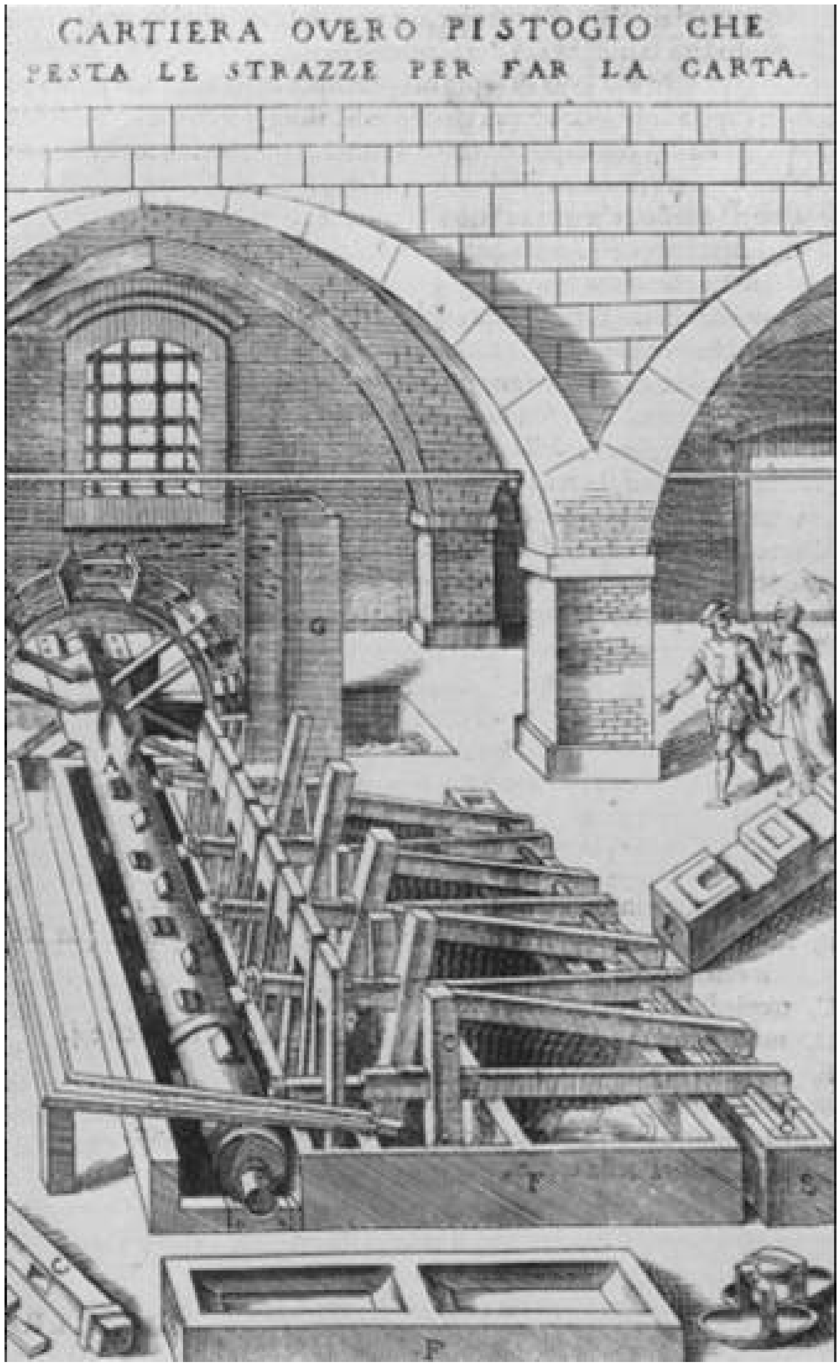

Figure 8.9: **Italian paper-mill, probably from the 16th century.**

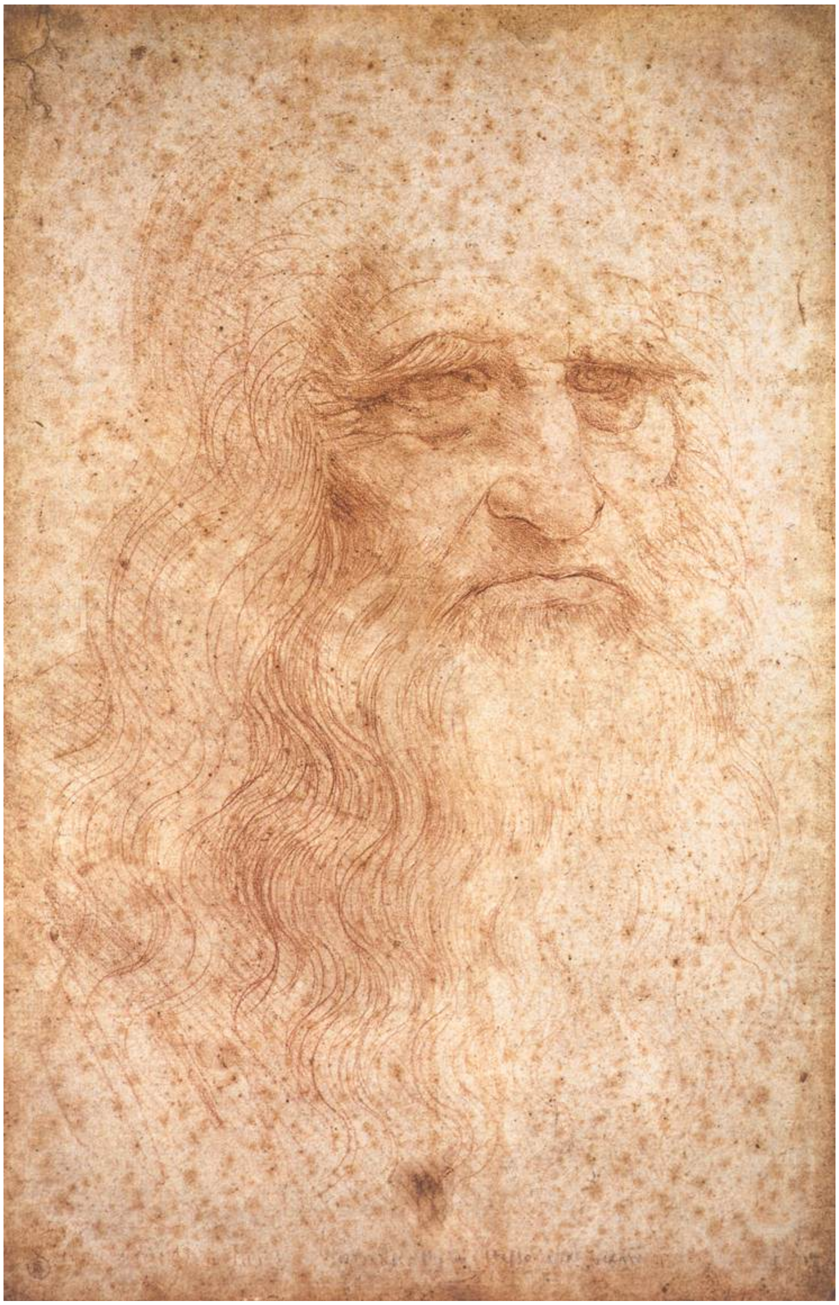

Figure 8.10: **The impact of Leonardo da Vinci's genius would have been far greater if his thousands of pages of notes had been printed.**

8.3 Illiteracy today

According to Wikipedia,

Many policy analysts consider literacy rates as a crucial measure of the value of a region's human capital. For example, literate people can be more easily trained than illiterate people, and generally have a higher socioeconomic status; thus they enjoy better health and employment prospects. The international community has come to consider literacy as a key facilitator and goal of development. In regard to the Sustainable Development Goals adopted by the UN in 2015, the UNESCO Institute for Lifelong Learning has declared the "central role of literacy in responding to sustainable development challenges such as health, social equality, economic empowerment and environmental sustainability".

Print illiteracy generally corresponds with less knowledge about modern hygiene and nutritional practices, an unawareness which can exacerbate a wide range of health issues. Within developing countries in particular, literacy rates also have implications for child mortality; in these contexts, children of literate mothers are 50% more likely to live past age 5 than children of illiterate mothers.[56] Public health research has thus increasingly concerned itself with the potential for literacy skills to allow women to more successfully access health care systems, and thereby facilitate gains in child health.

In 2013, the UNESCO Institute for Lifelong Learning published a set of case studies[79] on programs that successfully improved female literacy rates. The report features countries from a variety of regions and of differing income levels, reflecting the general global consensus on "the need to empower women through the acquisition of literacy skills." Part of the impetus for UNESCO's focus on literacy is a broader effort to respond to globalization and "the shift towards knowledge-based societies" that it has produced.[81] While globalization presents emerging challenges, it also provides new opportunities: many education and development specialists are hopeful that new ICTs will have the potential to expand literacy learning opportunities for children and adults, even those in countries that have historically struggled to improve literacy rates through more conventional means.

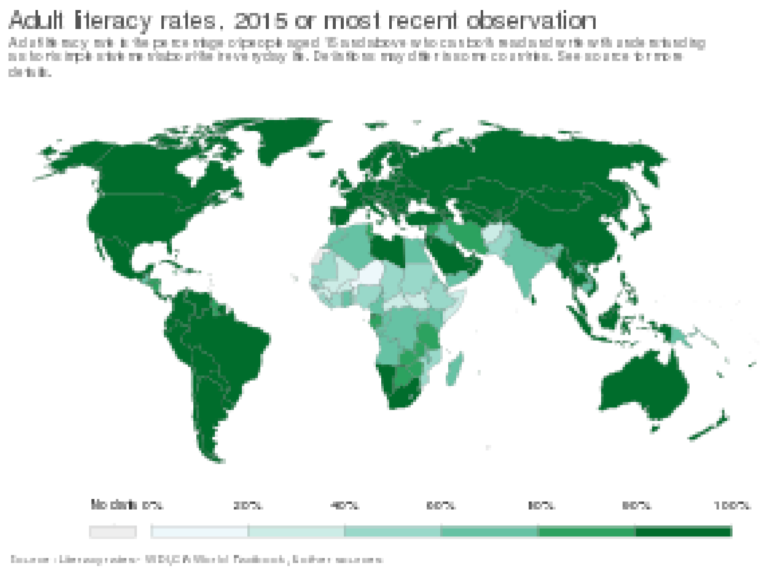

Figure 8.11: **Geographical distribution of adult literacy rates, 2015 or most recent observation. Sub-Saharan Africa, the region with the lowest overall literacy rates, also features the widest gender gap: just 52% of adult females are literate, and 68% among adult men. Similar gender disparity persists in two other regions, North Africa (86% adult male literacy, 70% adult female literacy) and South Asia (77% adult male literacy, 58% adult female literacy.)**

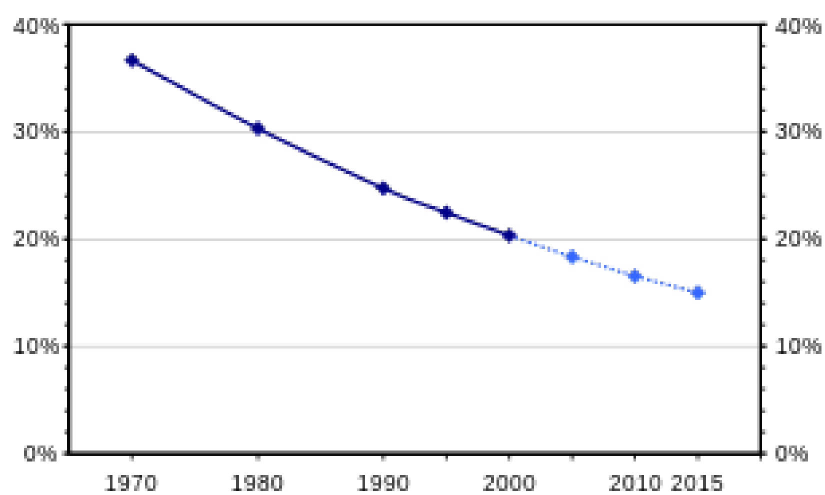

Figure 8.12: **World illiteracy has halved between 1970 and 2015, when measured as a percent of the total global population.**

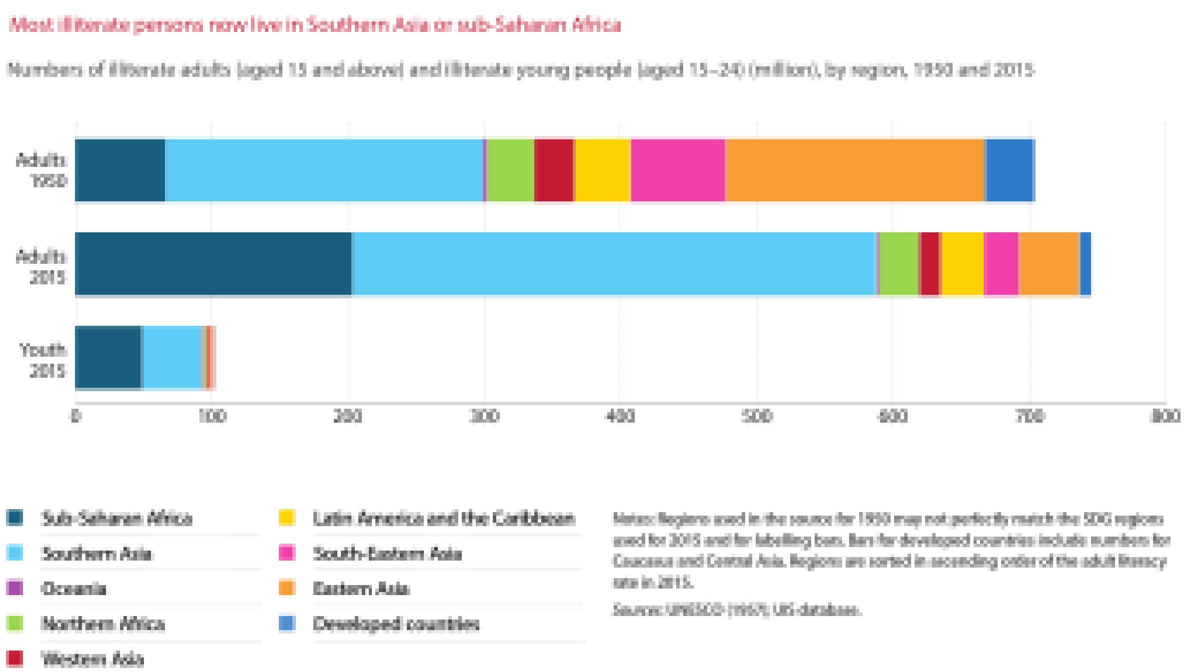

Figure 8.13: **Although the illiterate percentage of the world's population decreased between 1950 and 2015, the total number if illiterate people increased because of rapid population growth.**

8.4 UNESCO

Activities of UNESCO

UNESCO is a leader in the struggle against illiteracy. Here are some excerpts form the Wikipedia article on UNESCO:

UNESCO implements its activities through the five program areas: education, natural sciences, social and human sciences, culture, and communication and information.

- **Education: UNESCO supports research in comparative education; and provide expertise and fosters partnerships to strengthen national educational leadership and the capacity of countries to offer quality education for all. This includes the**
  - **UNESCO Chairs, an international network of 644 UNESCO Chairs, involving over 770 institutions in 126 countries.**
  - **Environmental Conservation Organization**
  - **Convention against Discrimination in Education adopted in 1960**
  - **Organization of the International Conference on Adult Education (CONFINTEA) in an interval of 12 years**
  - **Publication of the Education for All Global Monitoring Report**
  - **Publication of the Four Pillars of Learning seminal document**
  - **UNESCO ASPNet, an international network of 8,000 schools in 170 countries**
- **Designating projects and places of cultural and scientific significance, such as:**
  - **Global Geoparks Network**
  - **Biosphere reserves, through the Programme on Man and the Biosphere (MAB), since 1971**
  - **City of Literature; in 2007, the first city to be given this title was Edinburgh, the site of Scotland's first circulating library.[51] In 2008, Iowa City, Iowa became the City of Literature.**
  - **Endangered languages and linguistic diversity projects**
  - **Masterpieces of the Oral and Intangible Heritage of Humanity**
  - **Memory of the World International Register, since 1997**

Figure 8.14: **UNESCO's flag.**

  - Water resources management, through the International Hydrological Programme (IHP), since 1965
  - World Heritage Sites
  - World Digital Library

- Encouraging the "free flow of ideas by images and words" by:

  - Promoting freedom of expression, including freedom of the press and freedom of information legislation, through the Division of Freedom of Expression and Media Development,[52] including the International Programme for the Development of Communication
  - Promoting the safety of journalists and combatting impunity for those who attack them, through coordination of the UN Plan of Action on the Safety of Journalists and the Issue of Impunity
  - Promoting universal access to and preservation of information and open solutions for sustainable development through the Knowledge Societies Division,[56] including the Memory of the World Programme[57] and Information for All Programme
  - Promoting pluralism, gender equality and cultural diversity in the media
  - Promoting Internet Universality and its principles, that the Internet should be (I) human Rights-based, (ii) Open, (iii) Accessible to all, and (iv) nurtured by Multi-stakeholder participation (summarized as the acronym R.O.A.M.)

Figure 8.15: **Biologist, author, and environmentalist Sir Julian Huxley, first Director.General of UNESCO. He cane from a famous family whose members included Darwin's friend and defender, Thomas Henry Huxley, the novelist Aldous Huxley and the Nobel-laureate physiologist Sir Andrew Huxley.**

  - Generating knowledge through publications such as World Trends in Freedom of Expression and Media Development,[60] the UNESCO Series on Internet Freedom, and the Media Development Indicators, as well as other indicator-based studies.

Other activities of UNESCO

- Promoting events, such as:
  - International Decade for the Promotion of a Culture of Peace and Non-Violence for the Children of the World: 2001-2010, proclaimed by the UN in 1998
  - World Press Freedom Day, 3 May each year, to promote freedom of expression and freedom of the press as a basic human right and as crucial components of any healthy, democratic and free society.
  - Crianca Esperanca in Brazil, in partnership with Rede Globo, to raise funds for community-based projects that foster social integration and violence prevention.
  - International Literacy Day
  - International Year for the Culture of Peace
  - Health Education for Behavior Change program in partnership with the Ministry of Education of Kenya which was financially supported by the Government of Azerbaijan to promote health education among 10-19-year-old young people who live in informal camp in Kibera, Nairobi. The project was carried out between September 2014 - December 2016.
- Founding and funding projects, such as:
  - Migration Museums Initiative: Promoting the establishment of museums for cultural dialogue with migrant populations.
  - UNESCO-CEPES, the European Centre for Higher Education: established in 1972 in Bucharest, Romania, as a de-centralized office to promote international co-operation in higher education in Europe as well as Canada, USA and Israel. Higher Education in Europe is its official journal.
  - Free Software Directory: since 1998 UNESCO and the Free Software Foundation have jointly funded this project cataloguing free software.
  - FRESH Focussing Resources on Effective School Health.
  - OANA, Organization of Asia-Pacific News Agencies

- **International Council of Science**
- **UNESCO Goodwill Ambassadors**
- **ASOMPS, Asian Symposium on Medicinal Plants and Spices, a series of scientific conferences held in Asia Botany 2000, a programme supporting taxonomy, and biological and cultural diversity of medicinal and ornamental plants, and their protection against environmental pollution**
- **The UNESCO Collection of Representative Works, translating works of world literature both to and from multiple languages, from 1948 to 2005**

  GoUNESCO, an umbrella of initiatives to make heritage fun supported by UNESCO, New Delhi Office

8.5 The 2000-2015 Education For All Report

Goal 1 - Early childhood care and education

Expanding and improving comprehensive early childhood care and education, especially for the most vulnerable and disadvantaged children

- Despite a drop in child mortality rates of nearly 50%, 6.3 million children under the age of 5 died in 2013 from causes that are mostly preventable.
- Progress in improving child nutrition has been considerable. Yet globally, one in four children are still short for their age - a sign of chronic deficiency in essential nutrients.
- In 2012, 184 million children were enrolled in pre-primary education worldwide, an increase of nearly two-thirds since 1999.

Goal 2 - Universal primary education

Ensuring that by 2015 all children, particularly girls, children in difficult circumstances and those belonging to ethnic minorities, have access to and complete free and compulsory primary education of good quality

- The primary school net enrolment ratio was 84% in 1999 and is estimated to reach 93% in 2015.
- Net enrolment ratios improved significantly, rising at least 20 percentage points from 1999 to 2012 in 17 countries, 11 of which were in sub-Saharan Africa.
- While some increases in enrolment ratios are evident, nearly 58 million children were out of school in 2012, and progress in reducing this number has stalled.

- Despite progress in access, dropout remains an issue: in 32 countries, mostly in sub-Saharan Africa, at least 20% of children enrolled are not expected to reach the last grade.

- By the 2015 deadline, one in six children in low and middle income countries - or almost 100 million - will not have completed primary school.

Goal 3 - Youth and adult skills

Ensuring that the learning needs of all young people and adults are met through equitable access to appropriate learning and life skills programmes

- Reflecting improved transition rates and higher retention rates, the lower secondary gross enrolment ratio increased from 71% in 1999 to 85% in 2012. Participation in lower secondary education has increased quickly since 1999. In Afghanistan, China, Ecuador, Mali and Morocco, the lower secondary gross enrolment ratio has increased by at least 25 percentage points.

- Inequality persists in the transition from primary to secondary school. For example, in the Philippines, just 69% of primary school graduates from the poorest families continued into lower secondary, compared with 94% from the richest households.

- A majority of the 94 low and middle income countries with information have legislated free lower secondary education since 1999. Of these, 66 have constitutional guarantees and 28 enacted other legal measures. As of 2015, only a few nations charge lower secondary school fees, including Botswana, Guinea, Papua New Guinea, South Africa and the United Republic of Tanzania.

Goal 4 - Adult literacy

Achieving a 50 per cent improvement in levels of adult literacy by 2015, especially for women, and equitable access to basic and continuing education for all adults

- There are about 781 million illiterate adults. The rate of illiteracy dropped slightly, from 18% in 2000 to an estimated 14% in 2015, which means the Dakar target of halving illiteracy was not achieved.

- Only 17 out of the 73 countries with a literacy rate below 95% in 2000 had halved their illiteracy rate by 2015.

- Progress has been made towards gender parity in literacy but is not sufficient. All 43 countries where fewer than 90 women for every 100 men were literate in 2000 have moved towards parity, but none of them will have reached it by 2015.

Goal 5 - Gender equality

Eliminating gender disparities in primary and secondary education by 2005, and achieving gender equality in education by 2015, with a focus on ensuring girls' full and equal access to and achievement in basic education of good quality.

- At the primary level, 69% of the countries with data are expected to have reached gender parity by 2015. Progress is slower in secondary education, with 48% projected to be at gender parity in 2015.
- Progress in tackling severe gender disparity has been made. Between 1999 and 2012, the number of countries with fewer than 90 girls enrolled in primary school for every 100 boys fell from 33 to 16.
- Amongst out-of-school children, girls are more likely than boys never to enrol in school (48% compared with 37%), while boys are more likely to leave school (26% compared with 20%). Once enrolled, girls are more likely to reach the upper grades.
- In sub-Saharan Africa, the poorest girls remain the most likely to never attend primary school. In Guinea and Niger in 2010, over 70% of the poorest girls had never attended primary school, compared with less than 20% of the richest boys.

Goal 6 - Quality of education

Improving all aspects of the quality of education and ensuring excellence of all so that recognized and measurable learning outcomes are achieved by all, especially in literacy, numeracy and essential life skills.

- Pupil/teacher ratios declined in 83% of the 146 countries with data at the primary education level. In one-third of the countries with data, however, less than 75% of primary school teachers are trained up to national standards.
- At the lower secondary education level, 87 of the 105 countries with data have a pupil/teacher ratio below 30:1.
- n 1990, 12 learning assessments were conducted according to national standards, but by 2013 the number had increased to 101.

Suggestions for further reading

1. Moats, Louisa (2000). *Speech to print: language essentials for teachers.* Baltimore, MD: Paul H. Brookes Pub.
2. Jack Goody (1986). *The Logic of Writing and the Organization of Society. Overview.* Cambridge University Press.
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4. Brian V. Street (1984). *Overview. Literacy in Theory and Practice.* Cambridge University Press.
5. Beach, Richard, Judith Green, Michael Kamil, and Timothy Shanahan (educator). *Multidisciplinary Perspectives on Literacy Research, 2nd ed.* Cresskill, NJ: Hampton P., 2005
6. Bazerman, Charles, et al., eds. (2018). *The Lifespan Development of Writing.* Urbana, IL: NCTE.
7. Michele Knobel (1999). *Everyday Literacies: Students, Discourse, and Social Practice*, New York: Lang
8. Kress, Gunther R. (2003). *Literacy in the new media age.* New York: Routledge.
9. McKenna, Michael C.; Richards, Janet C. (2003). *Integrating multiple literacies in K-8 classrooms: cases, commentaries, and practical applications.* Hillsdale, NJ: L. Erlbaum Associates.
10. Stuart Selber (2004). *Multiliteracies for a Digital Age.* Carbondale: Southern Illinois University Press.

Chapter 9

MASS MEDIA AND EDUCATION

9.1 Benefits of equality

The Industrial Revolution opened up an enormous gap in military strength between the industrialized nations and the rest of the world. Taking advantage of their superior weaponry, Europe, the United States and Japan rapidly carved up the remainder of the world into colonies, which acted as sources of raw materials and food, and as markets for manufactured goods. Between 1800 and 1914, the percentage of the earth under the domination of colonial powers increased to 85 percent, if former colonies are included.

The English economist and Fabian, John Atkinson Hobson (1858-1940), offered a famous explanation of the colonial era in his book "Imperialism: A Study" (1902). According to Hobson, the basic problem that led to colonial expansion was an excessively unequal distribution of incomes in the industrialized countries. The result of this unequal distribution was that neither the rich nor the poor could buy back the total output of their society. The incomes of the poor were insufficient, and rich were too few in number. The rich had finite needs, and tended to reinvest their money. As Hobson pointed out, reinvestment in new factories only made the situation worse by increasing output.

Hobson had been sent as a reporter by the Manchester Guardian to cover the Second Boer War. His experiences had convinced him that colonial wars have an economic motive. Such wars are fought, he believed, to facilitate investment of the excess money of the rich in African or Asian plantations and mines, and to make possible the overseas sale of excess manufactured goods. Hobson believed imperialism to be immoral, since it entails suffering both among colonial peoples and among the poor of the industrial nations. The cure that he recommended was a more equal distribution of incomes in the manufacturing countries.

Interestingly, TED Talks (ideas worth spreading) was recently under fire from many progressive groups for censoring a short talk by the adventure capitalist, Nick Hanauer, entitled "Income Inequality". In this talk, Hanauer said exactly the same thing as John Hobson, but he applies the ideas, not to colonialism, but to current unemployment in the United States. Hanauer said that the rich are unable to consume the products of society because they are too few in number. To make an economy work, demand must be increased,

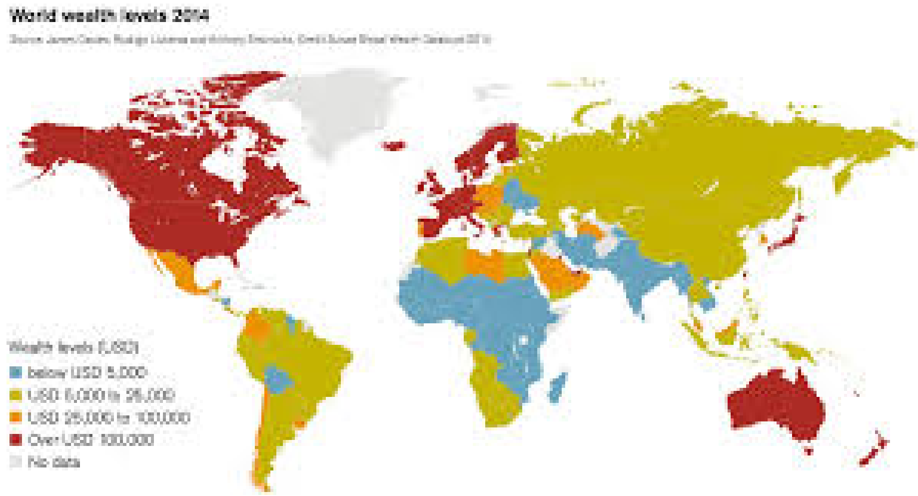

Figure 9.1: **World wealth levels in 2004. Countries with per capita wealth greater than 100,000 USD are shown in red, while those with per capita wealth less than 5,000 USD are shown in blue.**

and for this to happen, the distribution of incomes must become much more equal than it is today in the United States.

TED has now posted Hanauer's talk, and the interested reader can find another wonderful TED talk dealing with the same issues from the standpoint of health and social problems. In a splendid lecture entitled "How economic inequality harms societies", Richard Wilkinson demonstrates that there is almost no correlation between gross national product and a number of indicators of the quality of life, such as physical health, mental health, drug abuse, education, imprisonment, obesity, social mobility, trust, violence, teenage pregnancies and child well-being. On the other hand he offers comprehensive statistical evidence that these indicators are strongly correlated with the degree of inequality within countries, the outcomes being uniformly much better in nations where income is more equally distributed.

Warren Buffet famously remarked, "There's class warfare, all right. But it's my class, the rich class, that's making war, and we're winning." However, the evidence presented by Hobson, Hanauer and Wilkinson shows conclusively that no one wins in a society where inequality is too great, and everyone wins when incomes are more evenly distributed.

Figure 9.2: **In many countries, children live by scavenging from garbage dumps.**

Figure 9.3: **Even in rich countries, many millions of people live in poverty,**

9.2 Extreme inequality today

Here are some quotations from a report by the Global Inequality organization: [1]

Inequality has been on the rise across the globe for several decades. Some countries have reduced the numbers of people living in extreme poverty. But economic gaps have continued to grow as the very richest amass unprecedented levels of wealth. Among industrial nations, the United States is by far the most top-heavy, with much greater shares of national wealth and income going to the richest 1 percent than any other country.

The world's richest 1 percent, those with more than $1 million, own 45 percent of the world's wealth. Adults with less than $10,000 in wealth make up 64 percent of the world's population but hold less than 2 percent of global wealth. The world's wealthiest individuals, those owning over $100,000 in assets, total less than 10 percent of the global population but own 84 percent of global wealth. Credit Suisse defines "wealth" as the value of a household's financial assets plus real assets (principally housing), minus their debts.

"Ultra high net worth individuals" - the wealth management industry's term for people worth more than $30 million - hold an astoundingly disproportionate share of global wealth. These wealth owners hold 11.3 percent of total global wealth, yet represent only a tiny fraction (0.003%) of the world population.

The world's 10 richest billionaires, according to Forbes, own $745 billion in combined wealth, a sum greater than the total goods and services most nations produce on an annual basis. The globe is home to 2,208 billionaires, according to the 2018 Forbes ranking.

Those with extreme wealth have often accumulated their fortunes on the backs of people around the world who work for poor wages and under dangerous conditions. According to Oxfam, the wealth divide between the global billionaires and the bottom half of humanity is steadily growing. Between 2009 and 2017, the number of billionaires it took to equal the wealth of the world's poorest 50 percent fell from 380 to 42...

The United States has more wealth than any other nation. But America's top-heavy distribution of wealth leaves typical American adults with far less wealth than their counterparts in other industrial nations.

9.3 Oligarchy replaces democracy in many countries

The jaws of power

"Every government degenerates when trusted to the rulers of the people alone. The people themselves, therefore, are its only safe depositories." Thomas Jeffer-

[1] https://inequality.org/facts/global-inequality/

son, (1743-1826)

"The jaws of power are always open to devour, and her arm is always stretched out, if possible, to destroy the freedom of thinking, speaking, and writing." John Adams, (1735-1826)

According to the Nuremberg Principles, the citizens of a country have a responsibility for the crimes that their governments commit. But to prevent these crimes, the people need to have some knowledge of what is going on. Indeed, democracy cannot function at all without this knowledge.

What are we to think when governments make every effort to keep their actions secret from their own citizens? We can only conclude that although they may call themselves democracies, such governments are in fact oligarchies or dictatorships.

At the end of World War I, it was realized that secret treaties had been responsible for its outbreak, and an effort was made to ensure that diplomacy would be more open in the future. Needless to say, these efforts did not succeed, and diplomacy has remained a realm of secrecy.

Many governments have agencies for performing undercover operations (usually very dirty ones). We can think, for example of the KGB, the CIA, M5, or Mossad. How can countries that have such agencies claim to be democracies, when the voters have no knowledge of or influence over the acts that are committed by the secret agencies of their governments?

Nuclear weapons were developed in secret. It is doubtful whether the people of the United States would have approved of the development of such antihuman weapons, or their use against an already-defeated Japan, if they had known that these things were going to happen. The true motive for the nuclear bombings was also kept secret. In the words of General Groves, speaking confidentially to colleagues at Los Alamos, the real motive was "to control the Soviet Union".

The true circumstances surrounding the start of the Vietnam war would never have been known if Daniel Ellsberg had not leaked the Pentagon Papers. Ellsberg thought that once the American public realized that their country's entry into the war was based on a lie, the war would end. It did not end immediately, but undoubtedly Ellsberg's action contributed to the end of the war.

We do not know what will happen to Julian Assange. If his captors send him to the US, and if he is executed there for the crime of publishing leaked documents (a crime that he shares with the New York Times), he will not be the first martyr to the truth. The ageing Galileo was threatened with torture and forced to recant his heresy - that the earth moves around the sun. Galileo spent the remainder of his days in house arrest. Gordiano Bruno was less lucky. He was burned at the stake for maintaining that the universe is larger than it was then believed to be. If Julian Assange becomes a martyr to the truth like Galileo or Bruno, his name will be honored by generations in the future, and the shame of his captors will be remembered too.

The deep state

Can a government, many of whose operations are secret, be a democracy? Obviously this is impossible. The recent attempts of the United States to arrest whistleblower Edward Snowden call attention to the glaring contradiction between secrecy and democracy.

In a democracy, the power of judging and controlling governmental policy is supposed to be in the hands of the people. It is completely clear that if the people do not know what their government is doing, then they cannot judge or control governmental policy, and democracy has been abolished. There has always been a glaring contradiction between democracy and secret branches of the government, such as the CIA, which conducts its assassinations and its dirty wars in South America without any public knowledge or control.

The gross, wholesale electronic spying on citizens revealed by Snowden seems to be specifically aimed at eliminating democracy. It is aimed at instilling universal fear and conformity, fear of blackmail and fear of being out of step, so that the public will not dare to oppose whatever the government does, no matter how criminal or unconstitutional.

Henry Kissinger famously remarked: “The illegal we do at once. The unconstitutional takes a little longer”. Well, Henry, that may have been true in your time, but today the unconstitutional does not take long at all.

The Magna Carta is trashed. No one dares to speak up. Habeas Corpus is trashed. No one dares to speak up. The United Nations Charter is trashed. No one dares to speak up. The Universal Declaration of Human Rights is trashed. No one dares to speak up. The Fourth Amendment to the US Constitution is trashed. No one dares to speak up. The President claims the right to kill both US and foreign citizens, at his own whim. No one dares to speak up.

But perhaps this is unjust. Perhaps some people would dare to protest, except that they cannot get their protests published in the mainstream media. We must remember that the media are owned by the same corporate oligarchs who own the government.

George Orwell, you should be living today! We need your voice today! After Snowden’s revelations, the sale of Orwell’s “1984” soared. It is now on the bestseller list. Sadly, Orwell’s dystopian prophesy has proved to be accurate in every detail.

What is the excuse for for the massive spying reported by Snowden, spying not only on US citizens but also on the citizens of other countries throughout the world? “We want to protect you from terrorism.”, the government answers. But terrorism is not a real threat, it is an invented one. It was invented by the military-industrial complex because, at the end of the Cold War, this enormous money-making conglomerate lacked enemies.

Globally, the number of people killed by terrorism is vanishingly small compared to the number of children who die from starvation every year. It is even vanishingly small compared with the number of people who are killed in automobile accidents. It is certainly small compared with the number of people killed in wars aimed at gaining western hegemony over oil-rich regions of the world.

But in Shelley’s words, “We are many; they are few!” The people who want democracy greatly outnumber those who profit from maintaining a government based on secrecy and fear. Let us “rise like lions after slumbers, in unvanquishable numbers”. Let us abolish governmental secrecy and reclaim our democracy.

9.4 Media in the service of powerholders

Throughout history, art was commissioned by rulers to communicate, and exaggerate, their power, glory, absolute rightness etc, to the populace. The pyramids gave visual support to the power of the Pharaoh; portraits of rulers are a traditional form of propaganda supporting monarchies; and palaces were built as symbols of power.

Modern powerholders are also aware of the importance of propaganda. Thus the media are a battleground where reformers struggle for attention, but are defeated with great regularity by the wealth and power of the establishment. This is a tragedy because today there is an urgent need to make public opinion aware of the serious problems facing civilization, and the steps that are needed to solve these problems. The mass media could potentially be a great force for public education, but often their role is not only unhelpful - it is negative.

It is certainly possible to find a few television programs and newspaper articles that present the facts about climate change in a realistic way. For example *The Guardian* gives outstanding climate change coverage. However, the mass media could do very much more. One has to conclude that the media are neglecting their great responsibilities at a time of acute crisis for human civilization and the biosphere. The same can be said of our educational systems at both both the primary and advanced levels. We urgently need much more public education about the severe dangers that we face today.

9.5 Television as a part of our educational system

In the mid-1950's, television became cheap enough so that ordinary people in the industrialized countries could afford to own sets. During the infancy of television, its power was underestimated. The great power of television is due to the fact that it grips two senses simultaneously, both vision and hearing. The viewer becomes an almost-hypnotized captive of the broadcast.

In the 1950's, this enormous power, which can be used both for good and for ill, was not yet fully apparent. Thus insufficient attention was given to the role of television in education, in setting norms, and in establishing values. Television was not seen as an integral part of the total educational system. It is interesting to compare the educational systems of traditional cultures with those of modern industrial societies.

In traditional societies, multigenerational families often live together in the same dwelling. In general, there is a great deal of contact between grandparents and grandchildren, with much transmission of values and norms between generations. Old people are regarded with great respect, since they are considered to be repositories of wisdom, knowledge, and culture.

By contrast, modern societies usually favor nuclear families, consisting of only parents

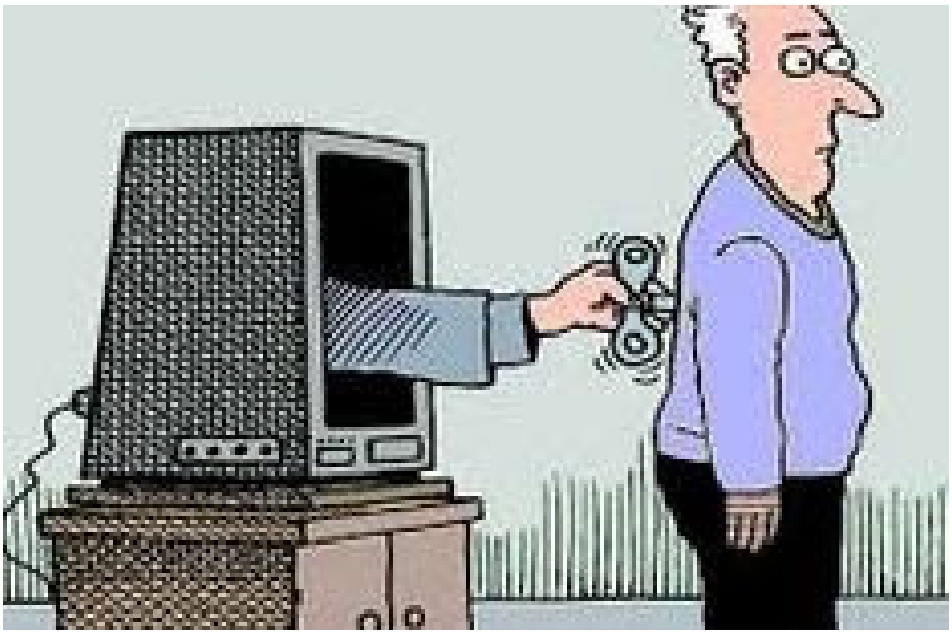

Figure 9.4: **The role of the media.**

Figure 9.5: **Liberty?**

and children. Old people are marginalized. They live by themselves in communities or homes especially for the old. Their cultural education knowledge and norms are not valued because they are "out of date". In fact, during the life of a young person in one of the rapidly-changing industrial societies of the modern world, there is often a period when they rebel against the authority of their parents and are acutely embarrassed by their parents, who are "so old-fashioned that they don't understand anything".

Although the intergenerational transmission of values, norms, and culture is much less important in industrial societies than it is in traditional ones, modern young people of the West and North are by no means at a loss over where to find their values, fashions and role models. With every breath, they inhale the values and norms of the mass media. Totally surrounded by a world of television and film images, they accept this world as their own.

9.6 Neglect of climate change in the mass media

The predicament of humanity today has been called "a race between education and catastrophe": How do the media fulfil this life-or-death responsibility? Do they give us insight? No, they give us pop music. Do they give us an understanding of the sweep of evolution and history? No, they give us sport. Do they give us an understanding of the ecological catastrophes that threaten our planet because of unrestricted growth of population and industries? No, they give us sit-coms and soap operas. Do they give us unbiased news? No, they give us news that has been edited to conform with the interests of powerful lobbys. Do they present us with the urgent need to leave fossil fuels in the ground? No, they do not, because this would offend the powerholders. Do they tell of the danger of passing tipping points after which human efforts to prevent catastrophic climate change will be useless? No, they give us programs about gardening and making food.

A consumer who subscribes to the "package" of broadcasts sold by a cable company can often search through all 95 channels without finding a single program that offers insight into the various problems that are facing the world today. What the viewer finds instead is a mixture of pro-establishment propaganda and entertainment. Meanwhile the neglected global problems are becoming progressively more severe.

In general, the mass media behave as though their role is to prevent the peoples of the world from joining hands and working to change the world and to save it from thermonuclear war, environmental catastrophes and threatened global famine. The television viewer sits slumped in a chair, passive, isolated, disempowered and stupefied. The future of the world hangs in the balance, the fate of children and grandchildren hangs in the balance, but the television viewer feels no impulse to work actively to change the world or to save it. The Roman emperors gave their people bread and circuses to numb them into political inactivity. The modern mass media seem to be playing a similar role.

Figure 9.6: **Network administrators have noticed that programs about climate change often have low viewer ratings. Since they see delivering high viewer ratings to their advertisers as their primary duty, these executives seldom allow programs dealing with the danger of catastrophic climate change. The duty to save the earth from environmental catastrophe is neglected for the sake of money. As Al Gore said, "Instead of having a well-informed electorate, we have a well-amused audience".**

9.7 Climate change denial in mass media

The Wikipedia article on climate change denial describes it with the following words: "Although scientific opinion on climate change is that human activity is extremely likely to be the primary driver of climate change, the politics of global warming have been affected by climate change denial, hindering efforts to prevent climate change and adapt to the warming climate. Those promoting denial commonly use rhetorical tactics to give the appearance of a scientific controversy where there is none."

It is not surprising that the fossil fuel industry supports, on a vast scale, politicians and mass media that deny the reality of climate change. The amounts of money at stake are vast. If catastrophic climate change is to be avoided, coal, oil and natural gas "assets" worth trillions of dollars must be left in the ground. Giant fossil fuel corporations are desperately attempting to turn these "assets' into cash.

Preventing an ecological apocalypse

Here are some excerpts from an article entitled **"Only Rebellion will prevent an ecological apocalypse"** by George Monbiot, which was published on April 15 2019 in The Guardian[2]:

No one is coming to save us. Mass civil disobedience is essential to force a political response.

Had we put as much effort into preventing environmental catastrophe as we've spent on making excuses for inaction, we would have solved it by now. Everywhere I look, I see people engaged in furious attempts to fend off the moral challenge it presents...

As the environmental crisis accelerates, and as protest movements like YouthStrike4Climate and Extinction Rebellion make it harder not to see what we face, people discover more inventive means of shutting their eyes and shedding responsibility. Underlying these excuses is a deep-rooted belief that if we really are in trouble, someone somewhere will come to our rescue: "they" won't let it happen. But there is no they, just us.

The political class, as anyone who has followed its progress over the past three years can surely now see, is chaotic, unwilling and, in isolation, strategically incapable of addressing even short-term crises, let alone a vast existential predicament. Yet a widespread and wilful naivety prevails: the belief that voting is the only political action required to change a system. Unless it is accompanied by the concentrated power of protest - articulating precise de-

[2]https://www.theguardian.com/commentisfree/2019/apr/15/rebellion-prevent-ecological-apocalypse-civil-disobedience

mands and creating space in which new political factions can grow - voting, while essential, remains a blunt and feeble instrument.

The media, with a few exceptions, is actively hostile. Even when broadcasters cover these issues, they carefully avoid any mention of power, talking about environmental collapse as if it is driven by mysterious, passive forces, and proposing microscopic fixes for vast structural problems. The BBC's Blue Planet Live series exemplified this tendency.

Those who govern the nation and shape public discourse cannot be trusted with the preservation of life on Earth. There is no benign authority preserving us from harm. No one is coming to save us. None of us can justifiably avoid the call to come together to save ourselves...

Predatory delay

Here are some excerpts from a May 3 2019 article by Bill Henderson entitled **"Neoliberalism, Solution Aversion, Implicatory Denial and Predatory Delay"**[3]:

Looking back at the history, that it's not really a failure of human beings and human nature that's the problem here. It's a hijacking of our political and economic system by the fossil fuel industry and a small number of like-minded people. It was our bad luck that this idea that markets solve all problems and that government should be left to wither away crested just at the moment when it could do the most damage.

Despite the urgent need to reduce greenhouse gas emissions globally if we are to lower the risks of catastrophic climate change, wealthy industrialized nations persist with a widespread public silence on the issue and fail to address climate change. This is despite there being ever more conclusive evidence of its severity. Why is there an undercurrent of inaction, despite the challenge of climate change being ever more daunting? One element is denial.

George Marshall discovered that there has not been a single proposal, debate or even position paper on limiting fossil fuel production put forward during international climate negotiations. From the very outset fossil fuel production lay outside the frame of the discussions and, as with other forms of socially constructed silence, the social norms among the negotiators and policy specialists kept it that way.

Global climate leadership is being redefined. There is a growing recognition that you cannot be a climate leader if you continue to enable new fossil fuel production, which is inconsistent with climate limits. If no major producers step up to stop the expansion of extraction and begin phasing out existing fields and mines, the Paris goals will become increasingly difficult to achieve.

[3]https://countercurrents.org/2019/05/03/neoliberalism-solution-aversion-implicatory-denial-and-predatory-delay-bill-henderson/

Wealthy fossil fuel producers have a responsibility to lead, and this must include planning for a just and equitable managed decline of existing production.

The (emissions reduction) curve we've been forced onto bends so steeply, that the pace of victory is part of victory itself. Winning slowly is basically the same thing as losing outright. We cannot afford to pursue past strategies, aimed at limited gains towards distant goals. In the face of both triumphant denialism and predatory delay, trying to achieve climate action by doing the same things, the same old ways, means defeat. It guarantees defeat.

A fast, emergency-scale transition to a post-fossil fuel world is absolutely necessary to address climate change. But this is excluded from consideration by policymakers because it is considered to be too disruptive. The orthodoxy is that there is time for an orderly economic transition within the current short-termist political paradigm. Discussion of what would be safe - less warming that we presently experience - is non-existent. And so we have a policy failure of epic proportions. Policymakers, in their magical thinking, imagine a mitigation path of gradual change, to be constructed over many decades in a growing, prosperous world...

9.8 Showing unsustainable lifestyles in mass media

Television and other mass media contribute indirectly to climate change denial by showing unsustainable lifestyles. Television dramas show the ubiquitous use of gasoline-powered automobiles and highways crowded with them. just as though there did not exist an urgent need to transform our transportation systems. Motor racing is shown. A program called "Top Gear" tells viewers about the desirability of various automobiles. In general, cyclists are not shown. In television dramas, the protagonists fly to various parts of the world for their holidays. The need for small local self-sustaining communities is not shown.

Advertisements in the mass media urge us to consume more, to fly, to purchase large houses, and to buy gasoline-driven automobiles, just as though such behavior ought to be the norm. Such norms are leading us towards environmental disaster.

9.9 Alternative media

Luckily, the mass media do not have a complete monopoly on public information. With a little effort, citizens who are concerned about the future can find alternative media. These include a large number if independent on-line news services that are supported by subscriber donations rather than by corporate sponsors. *YouTube* videos also represent an extremely important source of public information.

9.10 Outstanding voices calling for climate action

The Guardian

There are exceptions to the general rule that the mass media downplay or completely ignore the climate emergency. The Guardian is a newspaper with absolutely outstanding coverage of all issues related to climate change. No praise can be strong enough for the courageous environmental editorial policy of this famous old British newspaper.

Al Gore

Albert Arnold Gore Jr. served as the 45th Vice President of the United States from January 1985 to January 1993. He then ran for the office of President, but was defeated by George W. Bush in a controversial election whose outcome was finally decided by the US Supreme Court[4].

Al Gore is the founder and current Chairman of the Alliance for Climate Protection. He was one of the first important political figures to call attention to the problem of steadily increasing CO_2 levels in the atmosphere and the threat of catastrophic climate change. He produced the highly influential documentary film *An Inconvenient Truth*[5]. Because of his important efforts to save the global environment, Al Gore shared the 2007 Nobel Peace Prize with the Intergovernmental Panel on Climate Change.

[4] Many people believe that Al Gore won the election.
[5] https://www.youtube.com/watch?v=I-SV13UQXdk

Al Gore's TED talk: The Case for Optimism on Climate Change

In 2016, Al Gore gave an important talk to a TED audience[6]. in which he pointed out the an economic tipping point has just been passed. Solar energy and wind energy are now cheaper than energy form fossil fuels. This means that economic forces alone can drive a rapid transition to 100% renewable energy. Investors will realize that renewables represent an unparalleled investment opportunity.

Sir David Attenborough

In a 2011 interview in The Guardian, Sir David Attenborough was asked: "What will it take to wake people up about climate change?". He replied "Disaster. It's a terrible thing to say, isn't it? And even disaster doesn't always do it. I mean, goodness me, there have been disasters in North America, with hurricanes, and one thing and another, and floods; and still a lot of people would deny it, and say it's nothing to do with climate change. Well it visibly has to do with climate change!"

Sir David Attenborough's almost unbelievably enormous and impressive opus of television programs about the natural world have helped to raise public awareness of the importance of the natural environment. He also has made a number of television programs specifically related to questions such as saving threatened species, the dangers of exploding global human populations, and the destruction of forests for the sake of palm oil plantations.

Let us return to The Guardian's 2011 interview with Sir David. Had it been made in the autumn of 2017, the interview would certainly have included a discussion of recent hurricanes of unprecedented power and destructiveness, such as Harvey, Irma and Maria, as well as 2017's wildfires and Asian floods. It is possible that such events, which will certainly become more frequent and severe during the next few years, will provide the political will needed to silence climate change denial, to stop fossil fuel extraction, and to promote governmental policies favoring renewable energy.

Although the mass media almost have entirely neglected the link between climate change and recent disastrous hurricanes, floods droughts and wildfires, many individuals and organizations emphasized the cause and effect relationship. For example, UK airline billionaire Sir Richard Branson, whose Caribbean summer residence was destroyed by Hurricane Irma said:

"Look, you can never be 100 percent sure about links, But scientists have said the storms are going to get more and more and more intense and more and more often. We've had four storms within a month, all far greater than that have ever, ever, ever happened in history, Sadly, I think this is the start of things to come. Climate change is real. Ninety-nine percent of scientists know it's real. The whole world knows it's real except for maybe one person in the White House."

May Boeve, executive director of the NGO 350.org, said "With a few exceptions, the major TV networks completely failed to cover the scientifically proven ways that climate

[6]https://www.youtube.com/watch?v=I-SV13UQXdk

change is intensifying extreme weather events like hurricanes Harvey and Irma. That's not just disappointing, it's dangerous. We won't be able to turn this crisis around if our media is asleep at the wheel."

Commenting on the destruction of Puerto Rico by Hurricane Maria, historian Juan Cole wrote: "When you vote for denialist politicians, you are selecting people who make policy. The policy they make will be clueless and will actively endanger the public. Climate change is real. We are causing it by our emissions. If you don't believe that, you are not a responsible steward of our infrastructure and of our lives."

When interviewed by Amy Goodman of *Democracy Now*, musician Stevie Wonder said: "... we should begin to love and value our planet, and anyone who believes that there is no such thing as global warming must be blind or unintelligent."

Another well-known musician, Byoncé, added: "The effects of climate change are playing out around the world every day. Just this past week, we've seen devastation from the monsoon in India...and multiple catastrophic hurricanes. Irma alone has left a trail of death and destruction from the Caribbean to Florida to Southern United States. We have to be prepared for what comes next..."

In her September 2017 publication *Season of Smoke*[7], prizewinning author Naomi Klein wrote:

"We hear about the record-setting amounts of water that Hurricane Harvey dumped on Houston and other Gulf cities and towns, mixing with petrochemicals to pollute and poison on an unfathomable scale. We hear too about the epic floods that have displaced hundreds of thousands of people from Bangladesh to Nigeria (though we don't hear enough). And we are witnessing, yet again, the fearsome force of water and wind as Hurricane Irma, one of the most powerful storms ever recorded, leaves devastation behind in the Caribbean, with Florida now in its sights.

"Yet for large parts of North America, Europe, and Africa, this summer has not been about water at all. In fact it has been about its absence; it's been about land so dry and heat so oppressive that forested mountains exploded into smoke like volcanoes. It's been about fires fierce enough to jump the Columbia River; fast enough to light up the outskirts of Los Angeles like an invading army; and pervasive enough to threaten natural treasures, like the tallest and most ancient sequoia trees and Glacier National Park.

"For millions of people from California to Greenland, Oregon to Portugal, British Columbia to Montana, Siberia to South Africa, the summer of 2017 has been the summer of fire. And more than anything else, it's been the summer of ubiquitous, inescapable smoke.

"For years, climate scientists have warned us that a warming world is an extreme world, in which humanity is buffeted by both brutalizing excesses and stifling absences of the core elements that have kept fragile life in equilibrium for millennia. At the end of the summer of 2017, with major cities submerged in water and others licked by flames, we are currently living through Exhibit A of this extreme world, one in which natural extremes

[7] https://theintercept.com/2017/09/09/in-a-summer-of-wildfires-and-hurricanes-my-son-asks-why-is-everything-going-wrong/

Figure 9.7: **Sir David Attenborough: "Disaster. It's a terrible thing to say, isn't it?"**

come head-to-head with social, racial, and economic ones."

It seems likely that the climate-linked disasters of 2019 and 2020 will be even more severe than those that we have witnessed during 2017 and 2018. But will such disasters be enough to wake us up?

The BBC has recently announced that Sir David Attenborough is currently producing a new series, *Blue Planet II*, which will focus on environmental issues.[8]

"My hope is that the world is coming to its senses ... I'm so old I remember a time when ... we didn't talk about climate change, we talked about animals and species extermination," Sir David told Greenpeace in an interview, "For the first time I'm beginning to think there is actually a groundswell, there is a change in the public view. I feel many more people are concerned and more aware of what the problems are. Young people - people who've got 50 years of their life ahead of them - they are thinking they ought to be doing something about this. That's a huge change."

Climate Change, The Facts

Now Sir David Attenborough has completed a new one-hour BBC program on the danger of catastrophic climate change. Here are some excerpts from an April 18 2019 review of the program by Rebecca Nicholson in The Guardian:

The Facts is a rousing call to arms. It is an alarm clock set at a horrifying volume. The first 40 minutes are given over to what Attenborough calls, without hyperbole, "our greatest threat in thousands of years". Expert af-

[8]http://www.bbcearth.com/blueplanet2/

Figure 9.8: **Speaking at the opening ceremony of COP24, the universally loved and respected naturalist Sir David Attenborough said: "If we don't take action, the collapse of our civilizations and the extinction of much of the natural world is on the horizon."**

ter expert explains the consequences of rising CO2 levels, on the ice caps, on coastal regions, on weather and wildlife and society itself. The most powerful moments are in footage shot not by expert crews who have spent years on location, but on shaky cameras, capturing the very moment at which the reality of our warming planet struck the person holding the phone. In Cairns, Australia, flying foxes are unable to survive the extreme temperatures; rescuers survey the terrible massacre, and we learn that while 350 were saved, 11,000 died. A man and his son talk through their escape from raging wildfires, over the film they took while attempting to drive through a cavern of blazing red trees. These are horror movies playing out in miniature. It is difficult to watch even five minutes of this and remain somehow neutral, or unconvinced.

Yet as I kept on, scribbling down an increasingly grim list of statistics, most of which I knew, vaguely, though compiled like this they finally sound as dreadful as they truly are - 20 of the warmest years on record happened in the last 22 years; Greenland's ice sheet is melting five times faster than it was 25 years ago - I started to wonder about responsibility, and if and where it would be placed. This would be a toothless film, in the end, if it were hamstrung by political neutrality, and if its inevitable "it's not too late" message rested solely on individuals and what relatively little tweaks we might make as consumers. What about corporations? What about governments?

Then, at that exact moment, having played the despair through to its crescendo, the experts served up unvarnished honesty. They lined up to lay out the facts, plain and simple. Fossil fuel companies are the most profitable businesses man has ever known, and they engage in PR offensives, using the same consultants as tobacco companies, and the resulting uncertainty and denial, designed to safeguard profits, has narrowed our window for action. It is unforgivable. I find it hard to believe that anyone, regardless of political affiliation, can watch footage of Trump calling climate change "a hoax ... a money-making industry" and not be left winded by such staggering ignorance or astonishing deceit, though it is, more likely, more bleakly, a catastrophic combination of the two. At least Nigel Lawson only appears here in archive footage, and his argument sounds limp, to put it kindly.

Climate Change: The Facts should not have to change minds, but perhaps it will change them anyway, or at least make this seem as pressing as it needs to be. With the Extinction Rebellion protests across London this week, disrupting day-to-day business, and this, on primetime BBC One, maybe the message will filter through. At the very least, it should incite indignation that more was not done, sooner, and then urgency and a decision to both change and push for change at a much higher level. Because there is, for a brief moment, just possibly, still time.

Greta Thunberg meets Pope Francis

On 19 April 2019, Greta Thunberg met briefly with Pope Francis at the end of his general audience. "Continue, continue!" the Pope told her, "Go on, go ahead!" Greta answered Pope Francis with the words: "Thank you for standing up for the climate, for speaking the truth. It means a lot." Greta's father, Svante Thunberg, expressed his gratitude to the pope: "Thank you so much for what you are doing. It means everything. Everything."

The Pope has made fighting climate change and caring for God's creation a pillar of his papacy. He wrote an entire encyclical about it, blaming a thirst for money for turning the Earth into a wasteland and demanding immediate action to curb global warming.

While in Rome, Greta Thunberg will also address the Italian Parliament and participate in a school strike for action to avoid catastrophic climate change.

In June, 2015, His Holiness Pope Francis I addressed the climate crisis in an encyclical entitled "Laudato Si' "[9]. Here are a few excerpts from this enormously important encyclical, which is addressed not only to the world's 1.2 billion Catholics, but also to concerned people of all faiths. After reviewing the contributions of his predecessors. Pope Francis makes the following points:

23. The climate is a common good, belonging to all and meant for all. At the global level, it is a complex system linked to many of the essential conditions

[9]https://unfccc.int/news/pope-francis-releases-encyclical-on-climate-and-environment

for human life. A very solid scientific consensus indicates that we are presently witnessing a disturbing warming of the climatic system. In recent decades this warming has been accompanied by a constant rise in the sea level and, it would appear, by an increase of extreme weather events, even if a scientifically determinable cause cannot be assigned to each particular phenomenon. Humanity is called to recognize the need for changes of lifestyle, production and consumption, in order to combat this warming or at least the human causes which produce or aggravate it. It is true that there are other factors (such as volcanic activity, variations in the earth's orbit and axis, the solar cycle), yet a number of scientific studies indicate that most global warming in recent decades is due to the great concentration of greenhouse gases (carbon dioxide, methane, nitrogen oxides and others) released mainly as a result of human activity. As these gases build up in the atmosphere, they hamper the escape of heat produced by sunlight at the earth's surface. The problem is aggravated by a model of development based on the intensive use of fossil fuels, which is at the heart of the worldwide energy system. Another determining factor has been an increase in changed uses of the soil, principally deforestation for agricultural purposes.

24. Warming has effects on the carbon cycle. It creates a vicious circle which aggravates the situation even more, affecting the availability of essential resources like drinking water, energy and agricultural production in warmer regions, and leading to the extinction of part of the planet's biodiversity. The melting in the polar ice caps and in high altitude plains can lead to the dangerous release of methane gas, while the decomposition of frozen organic material can further increase the emission of carbon dioxide. Things are made worse by the loss of tropical forests which would otherwise help to mitigate climate change. Carbon dioxide pollution increases the acidification of the oceans and compromises the marine food chain. If present trends continue, this century may well witness extraordinary climate change and an unprecedented destruction of ecosystems, with serious consequences for all of us. A rise in the sea level, for example, can create extremely serious situations, if we consider that a quarter of the world's population lives on the coast or nearby, and that the majority of our megacities are situated in coastal areas.

25. Climate change is a global problem with grave implications: environmental, social, economic, political and for the distribution of goods. It represents one of the principal challenges facing humanity in our day. Its worst impact will probably be felt by developing countries in coming decades. Many of the poor live in areas particularly affected by phenomena related to warming, and their means of subsistence are largely dependent on natural reserves and ecosystemic services such as agriculture, fishing and forestry. They have no other financial activities or resources which can enable them to adapt to climate change or to

Figure 9.9: **Greta Thunberg had the privilege of meeting Pope Francis. Both are outstanding voices for climate action.**

face natural disasters, and their access to social services and protection is very limited. For example, changes in climate, to which animals and plants cannot adapt, lead them to migrate; this in turn affects the livelihood of the poor, who are then forced to leave their homes, with great uncertainty for their future and that of their children. There has been a tragic rise in the number of migrants seeking to flee from the growing poverty caused by environmental degradation. They are not recognized by international conventions as refugees; they bear the loss of the lives they have left behind, without enjoying any legal protection whatsoever. Sadly, there is widespread indifference to such suffering, which is even now taking place throughout our world. Our lack of response to these tragedies involving our brothers and sisters points to the loss of that sense of responsibility for our fellow men and women upon which all civil society is founded.

At a London event arranged by The Guardian, Greta Thunberg was asked whether she believed that a general strike could alert politicians to the urgency of the climate emergency. She replied "yes". Here are some of her other comments:

Figure 9.10: **Of the fossil fuels, all are bad, but coal is the worst.**

Figure 9.11: **Speaking to a crowd of many thousands at Marble Arch, London, on April 21, 2019, Greta Thunberg said: "For way too long the politicians and the people in power have gotten away with not doing anything ... But we will make sure that they will not get away with it any longer, We will never stop fighting, we will never stop fighting for this planet, for ourselves, our futures and for the futures of our children and grandchildren."**

This is not just young people being sick of politicians. It's an existential crisis. It is something that will affect the future of our civilization. It's not just a movement. It's a crisis and we must take action accordingly.

At a later meeting with members of the U.K. Parliament, Greta Thunberg said:

The U.K.'s active current support of new exploitation of fossil fuels, like for example the U.K. shale gas fracking industry, the expansion of its North Sea oil and gas fields, the expansion of airports, as well as the planning permission for a brand new coalmine, is beyond absurd.

This ongoing irresponsible behavior will no doubt be remembered in history as one of the greatest failures of humankind. .

Leonardo DiCaprio

Leonardo DiCaprio has won many awards for his work as an actor, writer and producer in both television and films. These include 50 awards from 167 nominations. DiCaprio has been nominated for six Academy Awards, four British Academy Film Awards and nine Screen Actors Guild Awards, winning one award each from them and three Golden Globe Awards from eleven nominations.

In accepting his Best Actor award at the 2016 Oscars ceremony, DiCaprio said: "Climate change is real, it is happening right now. It is the most urgent threat facing our entire species, and we need to work collectively together and stop procrastinating. We need to support leaders around the world who do not speak for the big polluters, but who speak for all of humanity, for the indigenous people of the world, for the billions and billions of underprivileged people out there who would be most affected by this. For our children's children, and for those people out there whose voices have been drowned out by the politics of greed."

Leonardo DiCaprio has used his great success as an actor in the service of environmental causes. In 1997, following the box office success of *Titanic*, he set up the Leonardo DiCaprio Foundation, which is devoted to environmental causes. He chaired the national Earth Day celebrations in 2000 during which he interviewed US President Bill Clinton, with whom he discussed the actions needed to avoid catastrophic climate change. In 2007 he had a major role in *The 11th Hour*, a documentary about people's relationship to nature and global warming. He also co-produced and co-wrote the film.

DiCaprio's most influential film on climate change is *Before the Flood*[10]. This film, released in 2016, is a 1 hour and 36 minute documentary in which Leonardo DiCaprio travels to many countries to let viewers observe the already visible effects of global warming. He also talks with many of the world's leaders, including Pope Francis I, US Presidents Bill Clinton and Barack Obama, and UN Secretary General Ban Ki-moon.

[10]http://www.get.filmovie.us/play.php?movie=tt5929776t

Figure 9.12: **Leonardo DiCaprio at a press conference in 2000 (Wikipedia).**

Figure 9.13: **Thom Hartmann speaks to the 2010 Chicago Green Festival (Wikipedia).**

Thom Hartmann

Thom Hartmann was born in 1951 in Lansing Michigan. He worked as a disk jockey during his teens, and, after a highly successful business career, he sold his businesses and devoted his energies to writing, humanitarian projects and public education. His influential book, *Last Hours of Ancient Sunlight* was published by Three Rivers Press in 1997 and republished in a revised edition in 2004. In 2013, Hartmann published another extremely important book on the same theme: *The Last Hours of Humanity: Warming the World To Extinction*[11].

Hartmann has hosted a nationally syndicated radio show, The Thom Hartmann Program, since 2003 and a nightly television show, The Big Picture, since 2008.

Concerning Hartmann's radio show, Wikipedia states that "As of March 2016, the show was carried on 80 terrestrial radio stations in 37 states as well as on Sirius and XM satellite radio. A community radio station in Africa, Radio Builsa in Ghana, also broadcasts the show. Various local cable TV networks simulcast the program. In addition to Westwood One, the show is now also offered via Pacifica Audioport to non-profit stations in a non-profit compliant format and is simulcast on Dish Network channel 9415 and DirecTV channel 348 via Free Speech TV. The program is carried on Radio Sputnik in London, England."

"Sen. Bernie Sanders (I-VT) appears every Friday during the first hour of the show titled 'Brunch with Bernie'. Ellen Ratner of the Talk Radio News Service provides Washington commentary daily. Victoria Jones who is the White House correspondent for Talk

[11] https://www.amazon.com/Last-Hours-Humanity-Warming-Extinction/dp/1629213640

Radio News Service appears occasionally as does Dr. Ravi Batra an economics professor at SMU."

Together with Leonardo DiCaprio, Thom Hartman recently produced and narrated an extremely important short film entitled *Last Hours*[12]. This film, draws a parallel between the Permian-Triassic mass extinction, and the danger of a human-induced 6th mass extinction. Various experts who appear in the film confirm that our release of CO_2 into the atmosphere is similar to the greenhouse gasses produced by volcanic eruptions prior to the Permian event. The methane hydrate feedback loop is also discussed. The film should be seen by everyone concerned with the future of human civilization and the biosphere. Concerned citizens should also urgently see Hartman and DiCaprio's short films *Carbon*, *Green World Rising* and *Reforestation*, also available on YouTube .

James Hansen

James Hansen was born in 1941 in Denison, Iowa. He was educated in physics, mathematics and astronomy at the University of Iowa in the space sciences program initiated James Van Allen. He graduated with great distinction. The studies of the atmosphere and temperature of Venus which Hansen made under Van Allen's supervision lead him to become extremely concerned about similar effects in the earth's atmosphere.

From 1962 to 1966, James Hansen participated in the National Aeronautical and Space Administration graduate traineeship and, at the same time, between 1965 and 1966, he was a visiting student at the Institute of Astrophysics at the University of Kyoto and in the Department of Astronomy at the University of Tokyo. Hansen then began work at the Goddard Institute for Space Studies in 1967. He began to work for the Goddard Institute for Space Studies in 1967. Between 1981 and 2913, he was hear of the Goddard Institute of Space Studies in New York, and since 2014, he has been the director of the Program on Climate Science, Awareness and Solutions at Columbia University's Earth Institute.

Hansen continued his work with radiative transfer models, attempting to understand the Venusian atmosphere. Later he applied and refined these models to understand the Earth's atmosphere, in particular, the effects that aerosols and trace gases have on Earth's climate. Hansen's development and use of global climate models has contributed to the further understanding of the Earth's climate. In 2009 his first book, Storms of My Grandchildren, was published.

James Hansen has refined climate change models, focusing on the balance between aerosols and greenhouse gases. He believes that there is a danger that climate change will become much more rapid if the balance shifts towards the greenhouse gases.

Hansen's Congressional testimony leads to broad public awareness of the dangers

In 1988, Prof. Hansen was asked to testify before the US Congress on the danger of uncontrolled climate change. The testimony marked the start of broad public awareness

[12]https://www.youtube.com/watch?v=2bRrg96UtMc

Figure 9.14: **Prof. James Hansen**

of the seriousness of the danger, and it was reported in a front page article by the New York Times. However, Hansen believes that governmental energy policies still favor fossil fuels. Therefore he has participated in public demonstrations and he was even arrested in 2011 together with more than a thousand other activists for protesting outside the White House.

James Hansen's TED talk and book

In 2012 he presented a TED Talk: *Why I Must Speak Out About Climate Change*. This talk is easily available on the Internet, and it should be required viewing for everyone who is concerned with the earth's future.

Hansen's book, *Storms of My Grandchildren: The Truth About The Coming Climate Catastrophe, and Our Last Chance To Save Humanity* was published in New York by Bloomsbury Publishing in 2009.

9.11 A culture of violence

Links with the entertainment industry

Here are a few films that glorify war:

- Black Hawk Down
- Top Gun
- Behind Enemy Lines
- Red Dawn (1984)

Figure 9.15: **Tom Cruse in "Top Gun".**

Figure 9.16: **A culture of violence supports the Devil's Dynamo.**

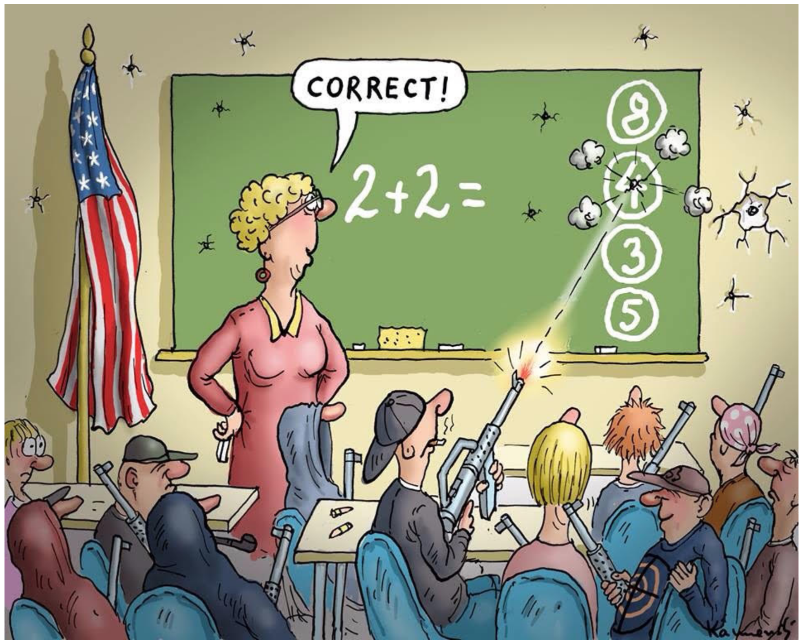

Figure 9.17: **A culture of violence: In the United States the National Rifle Association has proposed guns in schools as the answer to the epidemic of school shootings.**

- American Sniper
- Iron Eagle
- Pearl Harbor
- Act of Valor
- We Were Soldiers
- The Green Berets

Making a game of killing

The mass media are an important part of our educational system. Perhaps it is time to look more closely at the values that they are transmitting. In particular, we should perhaps look at computer games designed for young boys. They often give the strongest imaginable support to a culture of violence.

For example, a game entitled "Full Spectrum Warrior" was recently reviewed in a Danish newspaper. According to the reviewer, "...An almost perfect combination of graphics, sound, band design, and gameplay makes it seem exactly like the film Black Hawk Down - with the player as the main character. This is not just a coincidence, because the game is based on an army training program... Full Spectrum Warrior is an extremely intense experience, and despite the advanced possibilities, the controls are simple enough so that young children can play it... The player is completely drawn into the screen, and remains there until the end of the mission." The reviewer gave the game six stars (the maximum).

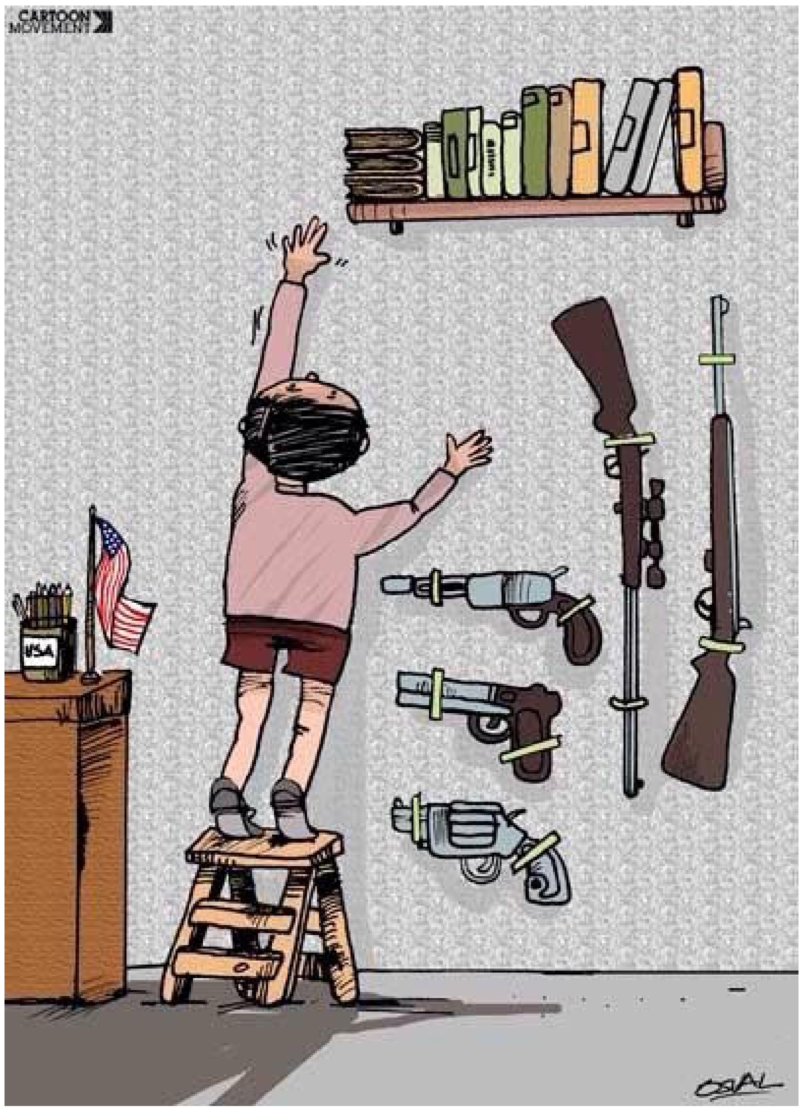

Figure 9.18: **A culture of violence. Guns in schools?**

Another genre of computer games has to do with building empires, ignoring the fact that imperialism is morally indefensible. For example, “Forge of Empires” is a browser-based strategy game. It is described as follows: “The game offers a single-player campaign for players to explore and conquer several provinces, gaining resources and new technology as they progress.” Conquering countries for the sake of gaining their resources is an all-too-familiar feature of the modern world. In the game “Forge of Empires”, our young people are indoctrinated with the ethos of resource wars.

During his trial, the Norwegian mass-murderer Anders Behring Breivik described how he trained for his attack on young people on the Island of UtÃ¸ya using the computer game “Call of Duty: Modern Warfare”. The court also heard how he took what he called a “sabatical” for a year between the summers of 2006 and 2007. During this year, he played a game called “World of Warcraft” full-time, in the bedroom of his mother’s Oslo flat, spending up to 16 hours a day using the game to distance himself from the human and moral significance of killing.

Is this not similar to the frame of mind of drone operators, sitting in comfort in their Nevada bunkers, distanced from the reality of killing? They are playing a computer game that kills targeted individuals and their families, in remote countries, by remote control. There is no need to look into the eyes of the victims. They are just abstract symbols in a computer game.

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Chapter 10

MISUSE OF EDUCATION

10.1 Abuse of apprenticeships

In many countries of Asia and the Middle East, carpets are woven by children as well as by adults. Often young girls are taught the art of carpet weaving by their grandmothers. This practice has the merit of ensuring that traditional skills are passed on between generations; but on the other hand, it deprives the children involved of the opportunity of a general education. Child labor can all too easily become child slavery.

Child labor and child slavery also occurred in Europe during the early stages of the Industrial Revolution. John Fielden's book, "The Curse of the Factory System" was written in 1836, and it describes the condition of young children working in the cotton mills. "The small nimble fingers of children being by far the most in request, the custom instantly sprang up of procuring 'apprentices' from the different parish workhouses of London, Birmingham and elsewhere... Overseers were appointed to see to the works, whose interest it was to work the children to the utmost, because their pay was in proportion to the quantity of work that they could exact."

"Cruelty was, of course, the consequence; and there is abundant evidence on record to

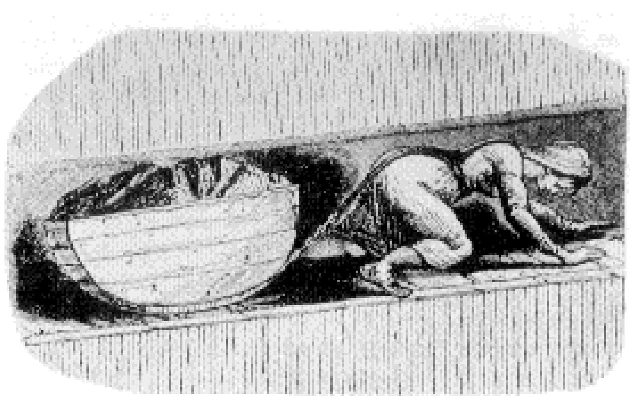

Figure 10.1: **A young girl pulling a tub of coal through a narrow seam.**

show that in many of the manufacturing districts, the most heart-rending cruelties were practiced on the unoffending and friendless creatures... that they were flogged, fettered and tortured in the most exquisite refinements of cruelty, that they were in many cases starved to the bone while flogged to their work, and that they were even in some instances driven to commit suicide... The profits of manufacture were enormous, but this only whetted the appetite that it should have satisfied."

With the gradual acceptance of birth control in England, the growth of trade unions, the passage of laws against child labor and finally minimum wage laws, conditions of workers gradually improved, and the benefits of industrialization began to spread to the whole of society. Among the changes which were needed to insure that the effects of technical progress became beneficial rather than harmful, the most important were the abolition of child labor, the development of unions, the minimum wage law, and the introduction of birth control.

One of the important influences for reform was the Fabian Society, founded in London in 1884. The group advocated gradual rather than revolutionary reform (and took its name from Quintus Fabius Maximus, the Roman general who defeated Hannibal's Carthaginian army by using harassment and attrition rather than head-on battles). The Fabian Society came to include a number of famous people, including Sydney and Beatrice Webb, George Bernard Shaw, H.G. Wells, Annie Besant, Leonard Woolf, Emaline Pankhurst, Bertrand Russell, John Maynard Keynes, Harold Laski, Ramsay MacDonald, Clement Attlee, Tony Benn and Harold Wilson. Jawaharlal Nehru, India's first Prime Minister, was greatly influenced by Fabian economic ideas.

The group was instrumental in founding the British Labour Party (1900), the London School of Economics and the New Statesman. In 1906, Fabians lobbied for a minimum wage law, and in 1911 they lobbied for the establishment of a National Health Service.

The reform movement's efforts, especially those of the Fabians, overcame the worst horrors of early 19th century industrialism, but today their hard-won achievements are being undermined and lost because of uncritical and unregulated globalization. Today, a factory owner or CEO, anxious to avoid high labor costs, and anxious to violate environmental regulations merely moves his factory to a country where laws against child labor and rape of the environment do not exist or are poorly enforced. In fact, he must do so or be fired, since the only thing that matters to the stockholders is the bottom line. One might say (as someone has done), that Adam Smith's invisible hand is at the throat of the world's peoples and at the throat of the global environment.

The movement of a factory from Europe or North America to a country with poorly enforced laws against environmental destruction, child labor and slavery puts workers into unfair competition. Unless they are willing to accept revival of the unspeakable conditions of the early Industrial Revolution, they are unable to compete.

Figure 10.2: **Beatrice Webb (1858-1943). Together with her husband Sidney Webb, Graham Wallace and George Bernard Shaw, she founded the Lon- don School of Economics using money left to the Fabian Society by Henry Hutchinson. The Fabians also founded the British Labour Party, and they lobbied for a minimum wage law and National Health Service.**

10.2 Child labor and slavery

Today, child labor accounts for 22 percent of the workforce in Asia, 32 percent in Africa, and 17 percent in Latin America. Large-scale slavery also exists today, although there are formal laws against it in every country. There are more slaves now than ever before. Their number is estimated to be between 12 million and 27 million. Besides outright slaves, who are bought and sold for as little as 100 dollars, there many millions of workers whose lack of options and dreadful working conditions must be described as slavelike.[1]

The CEO's of Wall Street call for less government, more deregulation and more globalization. They are delighted that the work of the reform movement is being undone in the name of "freedom". But is this really what is needed? Perhaps we need instead to reform our economic system to give it both a social conscience and an ecological conscience. Perhaps some of the things that the world produces and consumes today are not really necessary.

Governments already accept their responsibility for education. Perhaps in the future they will also accept the responsibility for insuring that their citizens can make a smooth transition from education to secure jobs. The free market alone cannot do this - the powers of government are needed. Let us restore democracy! Let us have governments that work for the welfare of all their citizens, rather than for the enormous enrichment of the few!

[1]http://www.commondreams.org/news/2015/08/04/state-dept-accused-watering-down-human-rights-ratings-advance-obama-trade-agenda
http://www.foodispower.org/slavery-chocolate/
https://www.wsws.org/en/articles/2014/10/01/modi-o01.html
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http://www.greenpeace.org/eastasia/campaigns/air-pollution/problems/
http://www.wired.com/2015/04/benedikt-partenheimer-particulate-matter/

Figure 10.3: **Forced labor often means unpaid wages, excessively long work hours without rest days, confiscation of ID documents, little freedom of movement, deception, intimidation and physical or sexual violence. ILO/A. Khemka**

Figure 10.4: **Photo source: Government of Andhra Pradesh, India.**

Figure 10.5: **A boy repairing a tyre in Ghana.**

Figure 10.6: **Young girl working on a loom in Aït Benhaddou, Morocco in May 2008.**

Figure 10.7: **Agriculture deploys 70% of the world's child labour. Above, child worker on a rice farm in Vietnam.**

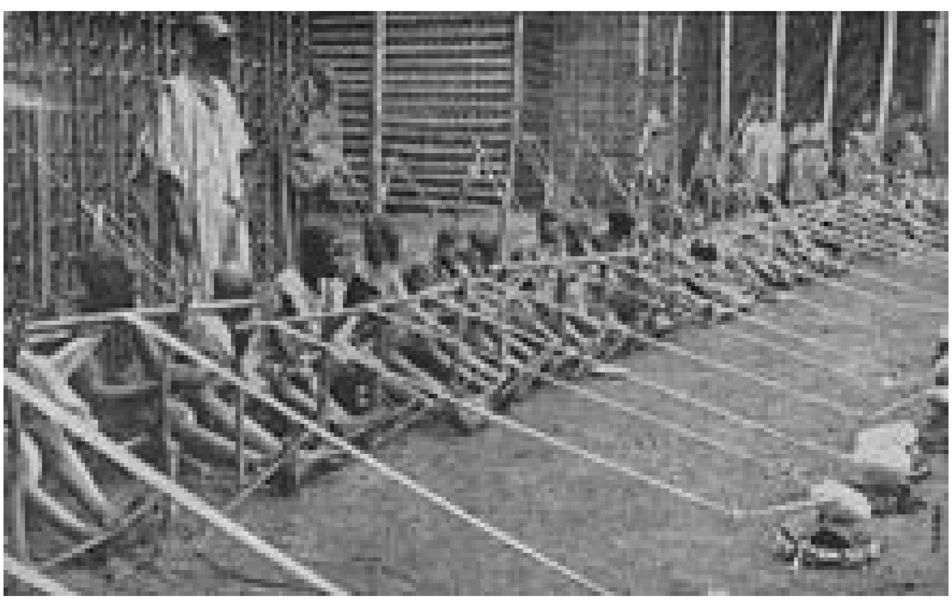


Figure 10.8: **Child labour in the former German colony of Kamerun, 1919.**

Figure 10.9: **Child labour in Brazil, leaving after collecting recyclables from a landfill.**

Figure 10.10: **A little girl making money for her family by posing with a snake in a water village of Tonle Sap Lake, Cambodia.**

Figure 10.11: **Working girl in India.**

Figure 10.12: **Child labour in Bangladesh.**

Figure 10.13: **Nepali girls working in brick factory.**

Figure 10.14: **Children engaged in diamond mining in Sierra Leone.**

Figure 10.15: **Working child in Ooty, India.**

Figure 10.16: **Child labour in a coal mine, United States, c. 1912.**

Figure 10.17: **Different forms of child labour in Central America, 1999.**

Illustration 14 -- No Title
Life (1883-1936); Apr 17, 1913; 61, 1590; American Periodicals
pg. 778

Child Labor Employer: GREAT GUNS! PLAYING! WHAT A WASTE OF HUMAN ENERGY

10.3 Literary protests against child labor

William Blake's *London*

I wandered through each chartered street
Near which the chartered Thames doth flow.
A mark in every face I meet,
Marks of weakness, marks of woe.

In every cry of every man,
In every infant's cry of fear,
In every voice, in every ban,
The mind-forged manacles I hear.

How the chimney-sweeper's cry
Every blackening church appalls,
And how the hapless soldier's sigh
Runs in blood down palace-walls.

But most, through midnight streets I hear
How the youthful harlot's curse
Blasts the new-born infant's tear,
And blights with plagues the marriage-hearse.

An excerpt from Blake's *Augeries of Innocence*

Every Night & every Morn
Some to Misery are Born
Every Morn and every Night
Some are Born to sweet delight
Some are Born to sweet delight
Some are Born to Endless Night.

Charles Dickens and Hans Christian Andersen

Some definitions (taken from the anti-slavery website)

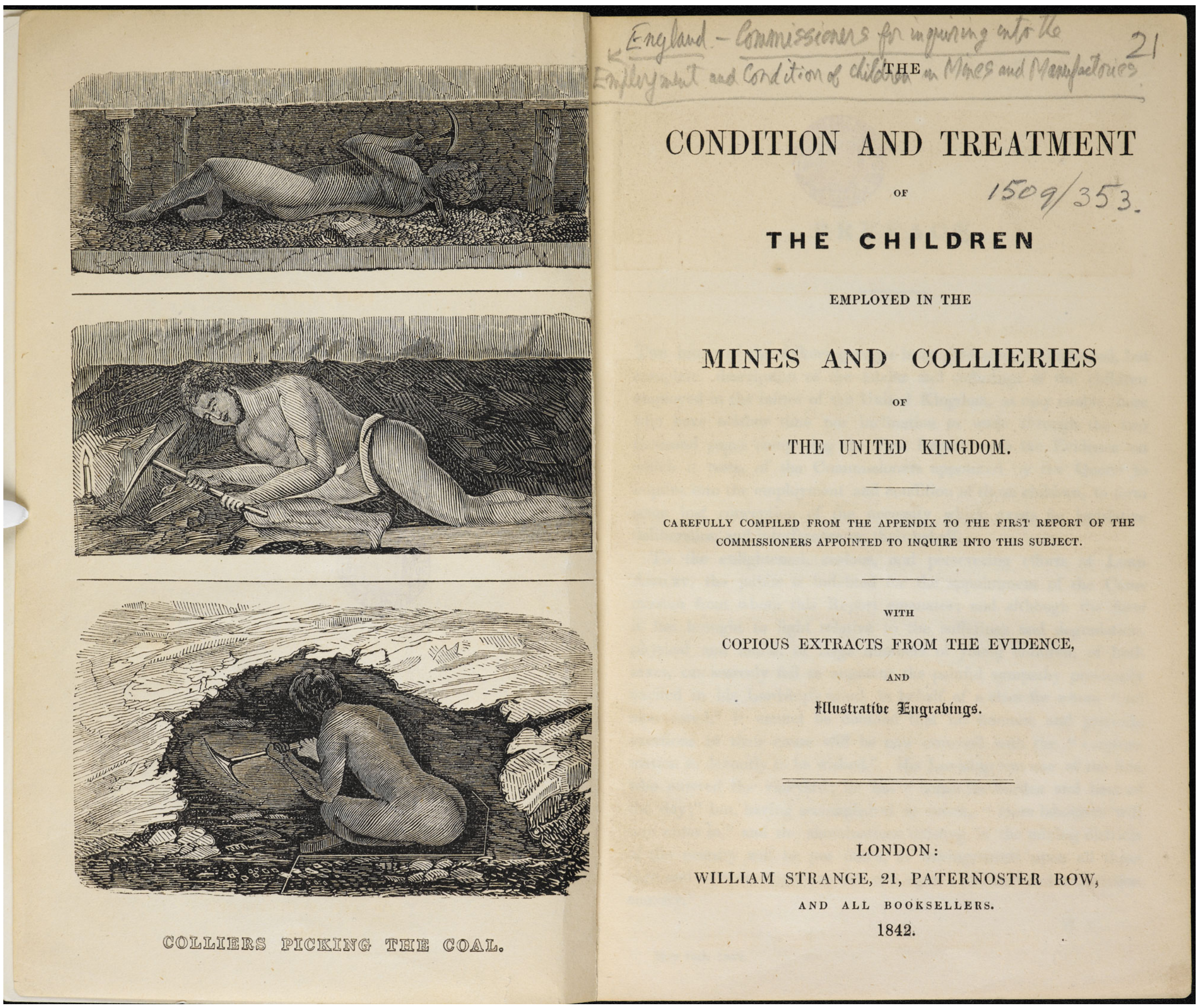
[2]

[2] https://www.antislavery.org/slavery-today/child-slavery/

Figure 10.18: **Tiny Tim, from Charles Dickens' *A Christmas Carol.* When he is informed that Tiny Tim will die unless he receives medical treatment, Scrooge remarks, "Then he had better die and reduce the surplus population!". Many of the events in Dickens' books can be viewed as protests against abuse of children.**

Figure 10.19: **Charles Dickens' Oliver Twist asks for a second portion of gruel, provoking a storm of outrage. As a boy, Dickens himself spent some time in a workhouse.**

Figure 10.20: **Hans Christian Andersen's heartbreaking story of *The Little Match Girl*.**



COLLIERS PICKING THE COAL.

England – Commissioners for inquiring into the Employment and Condition of children in Mines and Manufactories 21

THE

CONDITION AND TREATMENT

OF

1509/353.

THE CHILDREN

EMPLOYED IN THE

MINES AND COLLIERIES

OF

THE UNITED KINGDOM.

CAREFULLY COMPILED FROM THE APPENDIX TO THE FIRST REPORT OF THE COMMISSIONERS APPOINTED TO INQUIRE INTO THIS SUBJECT.

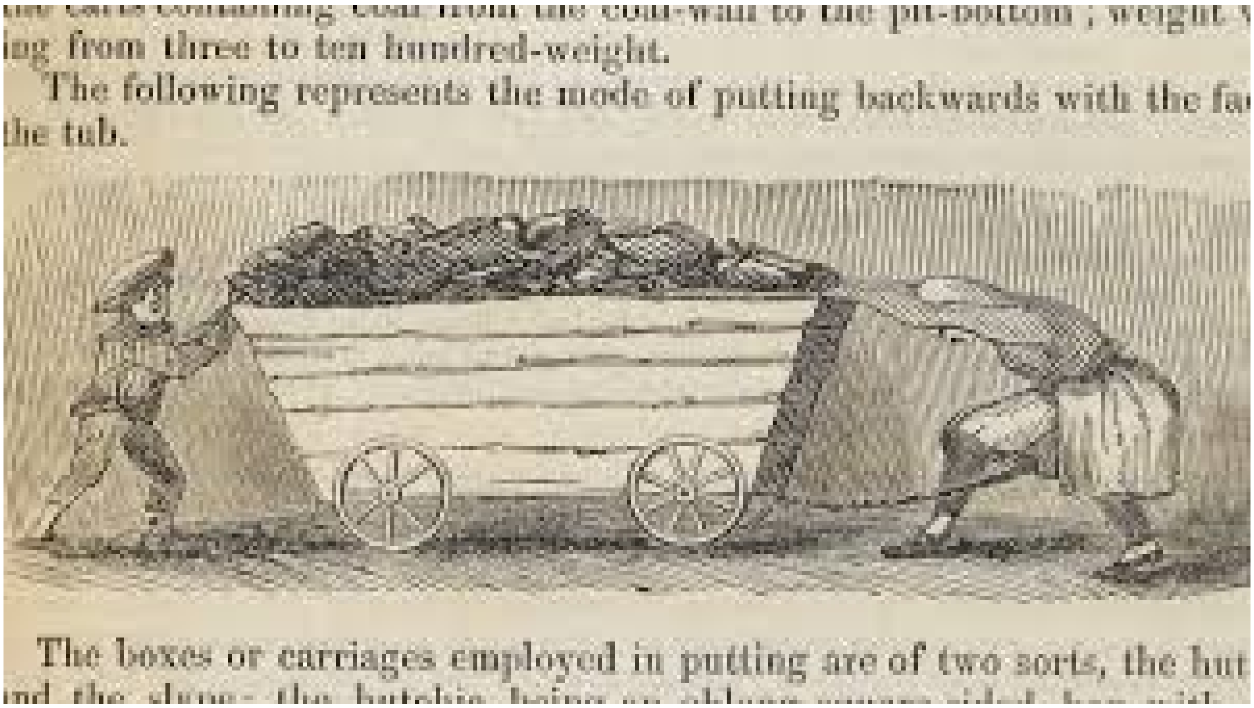
WITH

COPIOUS EXTRACTS FROM THE EVIDENCE,

AND

Illustrative Engravings.

LONDON:
WILLIAM STRANGE, 21, PATERNOSTER ROW,
AND ALL BOOKSELLERS.
1842.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The following represents the mode of putting backwards with the fa
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Child slavery includes

- Children used by others for profit, often through violence, abuse and threats, in prostitution or pornography, forced begging, petty crime and the drug trade.
- Forced child labour, for example in agriculture, factories, construction, brick kilns, mines, bars, the tourist industry or domestic work.
- Children forced to take part in armed conflicts.
- Children forced to marry.

Child work, child labour, child slavery?

- *Child work.* Some types of work make useful, positive contributions to a child's development, helping them learn useful skills. Often, work is a vital source of income for their families.
- *Child labour.* Child labour is not slavery, but nevertheless hinders children's education and development. Child labour tends to be undertaken when the child is in the care of their parents.
- *Worst form of child labour.* "Hazardous work" is the worst form of child labour. It irreversibly damages children's health and development through, for example, exposure to dangerous machinery or toxic substances, and may even endanger their lives.
- *Child slavery.* Child slavery is the enforced exploitation of a child for their labour for someone else's gain.
- *Child trafficking.* Trafficking involves transporting, recruiting or harboring people for the purpose of exploitation, using violence, threats or coercion. When children are trafficked, no violence, deception or coercion

needs to be involved, trafficking is merely the act of transporting or harboring them for exploitative work. When away from their families, they are at the mercy of their employers.

- *Child marriage.* Many marriages involving children will not amount to slavery, particularly between couples aged 16 to 18 years. But when a child didn't give their consent to a marriage, is exploited within it or is not able to leave, that child is in slavery.
- *Children in armed conflicts.* Children forced to take part in armed conflicts don't only include child soldiers but also porters or girls taken as "wives" for soldiers and militia members. Children involved in conflict are severely affected by their experiences and can suffer from long-term trauma.

Facts about child slavery

- Worldwide 10 million children are in slavery, trafficking, debt bondage and other forms of forced labour, forced recruitment for armed conflict, prostitution, pornography and other illicit activities (ILO)
- 151.6 million are estimated to be in child labour (ILO)
- 114 million child laborers are below the age of 14 (ILO)
- 72 million children are in hazardous work that directly endangers their health, safety and moral development (ILO)
- More than 700 million women alive today were married before their 18th birthday. More than one in three (about 250 million) entered into union before age 15 (UNICEF)
- 300,000 children are estimated to serve as child soldiers, some even younger than 10 years old (UNICEF)
- 15.5 million children are in domestic work worldwide - the overwhelming majority of them are girls (ILO)

10.4 Training of soldiers

Within individual countries, murder is rightly considered to be the worst of crimes. But the institution of war tries to convince us that if a soldier murders someone from another country, whom the politicians have designated as an "enemy", it is no longer a crime, no longer a violation of the common bonds of humanity. It is "heroic".

In their hearts, soldiers know that this is nonsense. Murder is always murder. The men, women and children who are supposed to be the "enemy", are just ordinary people, with whom the soldier really has no quarrel. Therefore when the training of soldiers wears off a little, so that they realize what they have done, they have to see themselves as murderers, and many commit suicide.

A recent article in the journal "Epidemiology" pointed out a startling statistic: for every American soldier killed in combat this year, 25 will commit suicide. The article also quotes the Department of Veterans Affairs, which says that 18 veterans commit suicide every day.

Obviously, the training of soldiers must overwrite fundamental ethical principles. This training must make a soldier abandon his or her individual conscience and sense of responsibility. It must turn the soldier from a compassionate human being into an automaton, a killing machine. How is this accomplished? Through erosion of of the soldier's self-respect. Through the endless repetition of senseless rituals where obedience is paramount and from which rational thought and conscience are banished.

In his book on fanaticism, The True Believer (1951), the American author Eric Hoffer gives the following description of the factors promoting self-sacrifice:

"To ripen a person for self-sacrifice, he must be stripped of his individual identity. He must cease to be George, Hans, Ivan or Tado - a human atom with an existence bounded by birth and death. The most drastic way to achieve this end is by the complete assimilation of the individual into a collective body. The fully assimilated individual does not see himself and others as human beings. When asked who he is, his automatic response is that he is a German, a Russian, a Japanese, a Christian, a Muslim, a member of a certain tribe or family. He has no purpose, worth or destiny apart from his collective body, and as long as that body lives, he cannot really die. ..."

"The effacement of individual separateness must be thorough. In every act, however trivial, the individual must, by some ritual, associate himself with the congregation, the tribe, the party, etcetera. His joys and sorrows, his pride and confidence must spring from the fortunes and capacities of the group, rather than from his individual prospects or abilities. Above all, he must never feel alone. Though stranded on a desert island, he must feel that he is under the eyes of the group. To be cast out from the group must be equivalent to being cut off from life."

"This is undoubtedly a primitive state of being, and its most perfect examples are found among primitive tribes. Mass movements strive to approximate this primitive perfection, and we are not imagining things when the anti-individualist bias of contemporary mass movements strikes us as being a throwback to the primitive."

The conditioning of a soldier in a modern army follows the pattern described in Eric

Hoffer's book. The soldier's training aims at abolishing his sense of individual separateness, individual responsibility, and moral judgment. It is filled with rituals, such as saluting, by which the soldier identifies with his tribe-like army group. His uniform also helps to strip him of his individual identity and to assimilate him into the group. The result of this psychological conditioning is that the soldier's mind reverts to a primitive state. He surrenders his moral responsibility, and when the politicians tell him to kill, he kills.

10.5 Hitler Youth

Here is an excerpt from the Wikipedia article on Hitler youth:

In 1922, the Munich-based Nazi Party established its official youth organisation called Jugendbund der NSDAP.It was announced on 8 March 1922 in the Völkischer Beobachter, and its inaugural meeting took place on 13 May the same year. Another youth group was established in 1922 as the Jungsturm Adolf Hitler. Based in Munich, Bavaria, it served to train and recruit future members of the Sturmabteilung (SA), the main paramilitary wing of the Nazi Party at that time.

One reason the Hitler Youth so easily came into existence stems from the fact that numerous youth movements existed across Germany prior to and especially after World War I. These youth organisations were created for varying purposes; some were religious in disposition and others were ideological, but the more important among them were those formed for political reasons, like the "Young Conservatives" or the "Young Protestants". Once Hitler came onto the revolutionary scene, the transition from seemingly innocuous youth movements to political entities focused on Hitler was swift...

The members of the Hitler Youth were viewed as ensuring the future of Nazi Germany and were indoctrinated in Nazi ideology, including racism. The Hitler Youth appropriated many of the activities of the Boy Scout movement (which was banned in 1935), including camping and hiking. However, over time it changed in content and intention. For example, many activities closely resembled military training, with weapons training, assault course circuits and basic tactics. The aim was to instill the motivation that would enable its members to fight faithfully for Nazi Germany as soldiers.[15] There was greater emphasis on physical fitness, hardness and military training than on academic study. Sacrifice for the cause was inculcated into their training. Former Hitler Youth, Franz Jagemann claimed for instance that the notion "Germany must live" even if they (members of the HJ) had to die was "hammered" into them.


wochit

Figure 10.21: **Hitler Youth at rifle practice, c. 1943.**

10.6 Cults

Here are some excerpts from the Wikipedia article on cults:

Destructiuve cults

"Destructive cult" generally refers to groups whose members have, through deliberate action, physically injured or killed other members of their own group or other people. The Ontario Consultants on Religious Tolerance specifically limits the use of the term to religious groups that "have caused or are liable to cause loss of life among their membership or the general public". Psychologist Michael Langone, executive director of the anti-cult group International Cultic Studies Association, defines a destructive cult as "a highly manipulative group which exploits and sometimes physically and/or psychologically damages members and recruits".

John Gordon Clark cited totalitarian systems of governance and an emphasis on money making as characteristics of a destructive cult. In Cults and the Family the authors cite Shapiro, who defines a "destructive cultism" as a sociopathic syndrome, whose distinctive qualities include: "behavioral and personality changes, loss of personal identity, cessation of scholastic activities, estrangement from family, disinterest in society and pronounced mental control

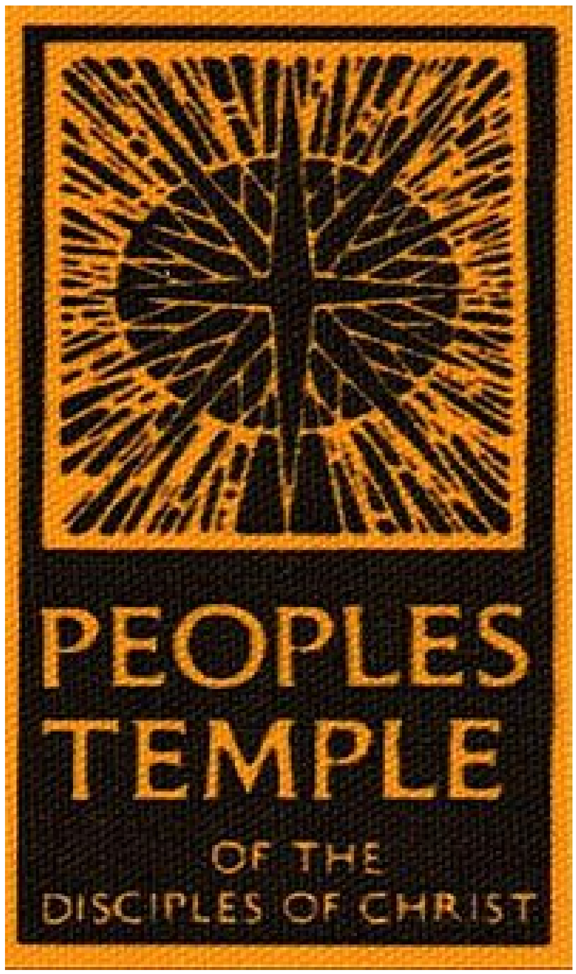

Figure 10.22: **The Temple is best known for the events of November 18, 1978, in Guyana, when 909 people died in a mass murder at its remote settlement, named "Jonestown", as well as the murders of U.S. Congressman Leo Ryan and members of his visiting delegation at the nearby Port Kaituma airstrip. The incident at Jonestown resulted in the greatest single loss of American civilian life in a deliberate act prior to the September 11 terrorist attacks.**

and enslavement by cult leaders"...

Political cults

...The Iron Guard movement of interwar Romania, which ruled the nation for a short time, has been referred to as a "macabre political cult", a cargo cult and a "cult of martyrdom and violence."

The followers of Ayn Rand were characterized as a cult by economist Murray N. Rothbard during her lifetime, and later by Michael Shermer. The core group around Rand was called the "Collective" and is now defunct (the chief group disseminating Rand's ideas today is the Ayn Rand Institute)...

Racist cults

Sociologist and historian Orlando Patterson has described the Ku Klux Klan, which arose in the American South after the Civil War, as a heretical Christian cult, and he has also described its persecution of African Americans and others as a form of human sacrifice. Secret Aryan cults in Germany and Austria in the nineteenth and early twentieth centuries had a strong influence on the rise of Nazism. Modern white power skinhead groups in the United States tend to use the same recruitment techniques as destructive cults.

Terrorist cults

...In an article on Al-Qaida published in The Times, journalist Mary Ann Sieghart wrote that al-Qaida resembles a "classic cult", commenting: "Al-Qaida fits all the official definitions of a cult. It indoctrinates its members; it forms a closed, totalitarian society; it has a self-appointed, messianic and charismatic leader; and it believes that the ends justify the means."

Similar to Al-Qaida, the Islamic State of Iraq and the Levant adheres to an even more extremist and puritanical ideology, in which the goal is to create a state i.e. a physical territory governed by its religious leadership's interpretation of shari'ah, which brainwashed and commanded its able-bodied male subjects to go on suicide missions with weapons, such as car bombs, against its enemies including deliberately selected civilian targets, such as churches and Shi'ite mosques among others. They viewed this as a legitimate action, indeed an obligation. The ultimate goal of this political-military endeavor was to eventually usher in the Islamic end times and have the chance to participate in their version of the apocalyptic battle, where all their enemies (i.e. anyone who wasn't on their side) would be annihilated...

Suggestions for further reading

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Chapter 11

EDUCATION AND THE INTERNET

11.1 The first computers

If civilization survives, historians in the distant future will undoubtedly regard the invention of computers as one of the most important steps in human cultural evolution - as important as the invention of writing or the invention of printing. The possibilities of artificial intelligence have barely begun to be explored, but already the impact of computers on society is enormous.

The first programmable universal computers were completed in the mid-1940's; but they had their roots in the much earlier ideas of Blaise Pascal (1623-1662), Gottfried Wilhelm Leibniz (1646-1716), Joseph Marie Jacquard (1752-1834) and Charles Babbage (1791-1871).

In 1642, the distinguished French mathematician and philosopher Blaise Pascal completed a working model of a machine for adding and subtracting. According to tradition, the idea for his "calculating box" came to Pascal when, as a young man of 17, he sat thinking of ways to help his father (who was a tax collector). In describing his machine, Pascal wrote: "I submit to the public a small machine of my own invention, by means of which you alone may, without any effort, perform all the operations of arithmetic, and may be relieved of the work which has often times fatigued your spirit when you have worked with the counters or with the pen."

Pascal's machine worked by means of toothed wheels. It was much improved by Leibniz, who constructed a mechanical calculator which, besides adding and subtracting, could also multiply and divide. His first machine was completed in 1671; and Leibniz' description of it, written in Latin, is preserved in the Royal Library at Hanover: "There are two parts of the machine, one designed for addition (and subtraction), and the other designed for multiplication (and division); and they should fit together. The adding (and subtracting) machine coincides completely with the calculating box of Pascal. Something, however, must be added for the sake of multiplication..."

Figure 11.1: **Blaise Pascal (1623-1662) was a French mathematician, physicist, writer, inventor and theologian. Pascal, a child prodigy, was educated by his father, who was a tax-collector. He invented his calculating box to make his father's work less tedious.**

Figure 11.2: **The German mathematician, philosopher and universal genius Gottfried Wilhelm von Leibniz (1646-1716) was a contemporary of Isaac Newton. He invented differential and integral calculus independently, just as Newton had done many years earlier. However, Newton had not published his work on calculus, and thus a bitter controversy over priority was precipitated. When his patron, the Elector of Hanover moved to England to become George I, Leibniz was left behind because the Elector feared that the controversy would alienate the English. Leibniz extended Pascal's calculating box so that it could perform multiplication and division. Calculators of his design were still being used in the 1960's.**

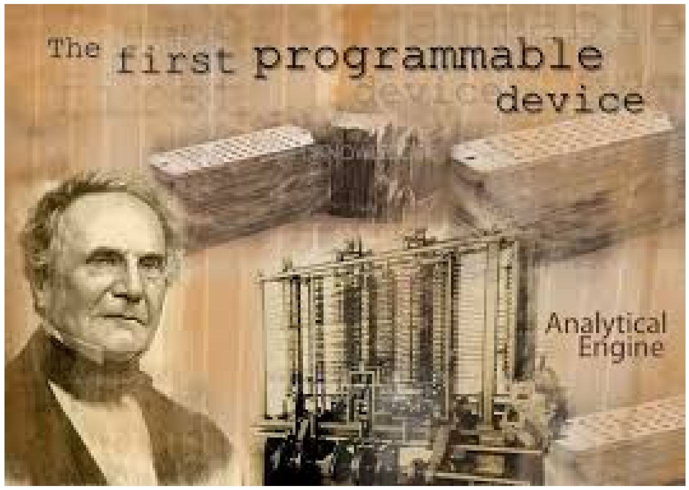

Figure 11.3: **Charles Babbage (1791-1871) and his analytical engine.**

"The wheels which represent the multiplicand are all of the same size, equal to that of the wheels of addition, and are also provided with ten teeth which, however, are movable so that at one time there should protrude 5, at another 6 teeth, etc., according to whether the multiplicand is to be represented five times or six times, etc."

"For example, the multiplicand 365 consists of three digits, 3, 6, and 5. Hence the same number of wheels is to be used. On these wheels, the multiplicand will be set if from the right wheel there protrude 5 teeth, from the middle wheel 6, and from the left wheel 3."

By 1810, calculating machines based on Leibniz' design were being manufactured commercially; and mechanical calculators of a similar (if much improved) design could be found in laboratories and offices until the 1960's. The idea of a programmable universal computer is due to the English mathematician, Charles Babbage, who was the Lucasian Professor of Mathematics at Cambridge University. (In the 17th century, Isaac Newton held this post, and in the 20th century, P.A.M. Dirac and Stephen Hawking also held it.)

In 1812, Babbage conceived the idea of constructing a machine which could automatically produce tables of functions, provided that the functions could be approximated by polynomials. He constructed a small machine, which was able to calculate tables of quadratic functions to eight decimal places, and in 1832 he demonstrated this machine to the Royal Society and to representatives of the British government.

The demonstration was so successful that Babbage secured financial support for the construction of a large machine which would tabulate sixth-order polynomials to twenty decimal places. The large machine was never completed, and twenty years later, after having spent seventeen thousand pounds on the project, the British government withdrew its support. The reason why Babbage's large machine was never finished can be understood from the following account by Lord Moulton of a visit to the mathematician's laboratory:

"One of the sad memories of my life is a visit to the celebrated mathematician and inventor, Mr. Babbage. He was far advanced in age, but his mind was still as vigorous as ever. He took me through his workrooms."

"In the first room I saw the parts of the original Calculating Machine, which had been shown in an incomplete state many years before, and had even been put to some use. I asked him about its present form. 'I have not finished it, because in working at it, I came on the idea of my Analytical Machine, which would do all that it was capable of doing, and much more. Indeed, the idea was so much simpler that it would have taken more work to complete the Calculating Machine than to design and construct the other in its entirety; so I turned my attention to the Analytical Machine.'"

"After a few minutes talk, we went into the next workroom, where he showed me the working of the elements of the Analytical Machine. I asked if I could see it. 'I have never completed it,' he said, 'because I hit upon the idea of doing the same thing by a different and far more effective method, and this rendered it useless to proceed on the old lines.'"

"Then we went into a third room. There lay scattered bits of mechanism, but I saw no trace of any working machine. Very cautiously I approached the subject, and received the dreaded answer: 'It is not constructed yet, but I am working at it, and will take less time to construct it altogether than it would have taken to complete the Analytical Machine from the stage in which I left it.' I took leave of the old man with a heavy heart."

Babbage's first calculating machine was a special-purpose mechanical computer, designed to tabulate polynomial functions; and he abandoned this design because he had hit on the idea of a universal programmable computer. Several years earlier, the French inventor Joseph Marie Jacquard had constructed an automatic loom in which large wooden "punched cards" were used to control the warp threads. Inspired by Jacquard's invention, Babbage planned to use punched cards to program his universal computer. (Jacquard's looms could be programmed to weave extremely complex patterns: A portrait of the inventor, woven on one of his looms in Lyon, hung in Babbage's drawing room.)

One of Babbage's frequent visitors was Augusta Ada[1], Countess of Lovelace (1815-1852), the daughter of Lord and Lady Byron. She was a mathematician of considerable ability, and it is through her lucid descriptions that we know how Babbage's never-completed Analytical Machine was to have worked.

The next step towards modern computers was taken by Herman Hollerith, a statistician working for the United States Bureau of the Census. He invented electromechanical machines for reading and sorting data punched onto cards. Hollerith's machines were used to analyze the data from the 1890 United States Census. Because the Census Bureau was a very limited market, Hollerith branched out and began to manufacture similar machines for use in business and administration. His company was later bought out by Thomas J. Watson, who changed its name to International Business Machines.

In 1937, Howard Aiken, of Harvard University, became interested in combining Babbage's ideas with some of the techniques which had developed from Hollerith's punched card machines. He approached the International Business Machine Corporation, the largest manufacturer of punched card equipment, with a proposal for the construction of a large, automatic, programmable calculating machine.

Aiken's machine, the Automatic Sequence Controlled Calculator (ASCC), was com-

[1] The programming language ADA is named after her.

Figure 11.4: **Joseph Marie Jacquard (1752-1834) invented a loom which could be programed to produce any design by means of punched cards. News of his invention inspired Babbage to invent a universal programmable computing machine.**

Figure 11.5: **Jacquard's loom.**

Figure 11.6: **Lord Byron's daughter, Augusta Ada, Countess of Lovelace (1815-1852) was an accomplished mathematician and a frequent visitor to Babbage's workshop. It is through her lucid description of his ideas that we know how Babbage's universal calculating machine was to have worked. The programming language ADA is named after her.**

Figure 11.7: **The Automatic Sequence-Controlled Calculator ASCC can still be seen by visitors at Harvard's science building and cafeteria.**

pleted in 1944 and presented to Harvard University. Based on geared wheels, in the Pascal-Leibniz-Babbage tradition, ASCC had more than three quarters of a million parts and used 500 miles of wire. ASCC was unbelievably slow by modern standards - it took three-tenths of a second to perform an addition - but it was one of the first programmable general-purpose digital computers ever completed. It remained in continuous use, day and night, for fifteen years.

In the ASCC, binary numbers were represented by relays, which could be either on or off. The on position represented 1, while the off position represented 0, these being the only two digits required to represent numbers in the binary (base 2) system. Electromechanical calculators similar to ASCC were developed independently by Konrad Zuse in Germany and by George R. Stibitz at the Bell Telephone Laboratory.

11.2 Electronic digital computers

In 1937, the English mathematician A.M. Turing published an important article in the Proceedings of the London Mathematical Society in which envisioned a type of calculating machine consisting of a long row of cells (the "tape"), a reading and writing head, and a set of instructions specifying the way in which the head should move the tape and modify the state and "color" of the cells on the tape. According to a hypothesis which came to be known as the "Church-Turing hypothesis", the type of computer proposed by Turing was capable of performing every possible type of calculation. In other words, the Turing machine could function as a universal computer.

In 1943, a group of English engineers, inspired by the ideas of Alan Turing and those of the mathematician M.H.A. Newman, completed the electronic digital computer Colossus. Colossus was the first large-scale electronic computer. It was used to break the German Enigma code; and it thus affected the course of World War II.

In 1946, ENIAC (Electronic Numerical Integrator and Calculator) became operational. This general-purpose computer, designed by J.P. Eckert and J.W. Mauchley of the Uni-

Figure 11.8: **Alan Turing (1912-1954). He is considered to be the father of theoretical computer science. During World War II, Turing's work allowed the allies to crack the German's code. This appreciably shortened the length of the war in Europe, and saved many lives.**

versity of Pennsylvania, contained 18,000 vacuum tubes, one or another of which was often out of order. However, during the periods when all its vacuum tubes were working, an electronic computer like Colossus or ENIAC could shoot ahead of an electromechanical machine (such as ASCC) like a hare outdistancing a tortoise.

During the summer of 1946, a course on "The Theory and Techniques of Electronic Digital Computers" was given at the University of Pennsylvania. The ideas put forward in this course had been worked out by a group of mathematicians and engineers headed by J.P. Eckert, J.W. Mauchley and John von Neumann, and these ideas very much influenced all subsequent computer design.

Figure 11.9: **John von Neumann (1903-1957, right) with J. Robert Oppenheimer. In the background is an electronic digital computer.**

11.3 Cybernetics

The word "Cybernetics", was coined by the American mathematician Norbert Wiener (1894-1964) and his colleagues, who defined it as "the entire field of control and communication theory, whether in the machine or in the animal". Wiener derived the word from the Greek term for "steersman".

Norbert Wiener began life as a child prodigy: He entered Tufts University at the age of 11 and received his Ph.D. from Harvard at 19. He later became a professor of mathematics at the Massachusetts Institute of Technology. In 1940, with war on the horizon, Wiener sent a memorandum to Vannevar Bush, another MIT professor who had done pioneering work with analogue computers, and had afterwards become the chairman of the U.S. National Defense Research Committee. Wiener's memorandum urged the American government to support the design and construction of electronic digital computers, which would make use of binary numbers, vacuum tubes, and rapid memories. In such machines, the memorandum emphasized, no human intervention should be required except when data was to be read into or out of the machine.

Like Leo Szilard, John von Neumann, Claude Shannon and Erwin Schrödinger, Norbert Wiener was aware of the relation between information and entropy. In his 1948 book Cybernetics he wrote: "...we had to develop a statistical theory of the amount of information, in which the unit amount of information was that transmitted by a single decision between equally probable alternatives. This idea occurred at about the same time to several writers, among them the statistician R.A. Fisher, Dr. Shannon of Bell Telephone Laboratories, and the author. Fisher's motive in studying this subject is to be found in classical statistical theory; that of Shannon in the problem of coding information; and that of the author in the problem of noise and message in electrical filters... The notion of the amount of in-

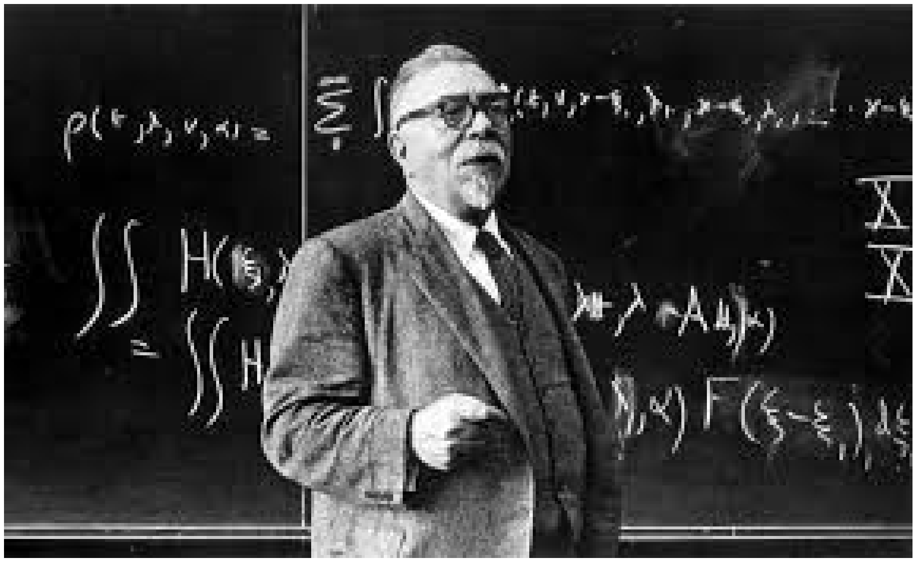

Figure 11.10: **MIT's Norbert Wiener (1894-1964) coined the word "Cybernetics", derived from a Greek word meaning "steersman". Wiener was one of the principle organizers of the Macy Conferences.**

formation attaches itself very naturally to a classical notion in statistical mechanics: that of entropy. Just as the amount of information in a system is a measure of its degree of organization, so the entropy of a system is a measure of its degree of disorganization; and the one is simply the negative of the other."

During World War II, Norbert Wiener developed automatic systems for control of anti-aircraft guns. His systems made use of feedback loops closely analogous to those with which animals coordinate their movements. In the early 1940's, he was invited to attend a series of monthly dinner parties organized by Arturo Rosenbluth, a professor of physiology at Harvard University. The purpose of these dinners was to promote discussions and collaborations between scientists belonging to different disciplines. The discussions which took place at these dinners made both Wiener and Rosenbluth aware of the relatedness of a set of problems that included homeostasis and feedback in biology, communication and control mechanisms in neurophysiology, social communication among animals (or humans), and control and communication involving machines.

Wiener and Rosenbluth therefore tried to bring together workers in the relevant fields to try to develop common terminology and methods. Among the many people whom they contacted were the anthropologists Gregory Bateson and Margaret Mead, Howard Aiken (the designer of the Automatic Sequence Controlled Calculator), and the mathematician John von Neumann. The Josiah Macy Jr. Foundation sponsored a series of ten yearly meetings, which continued until 1949 and which established cybernetics as a new research discipline. It united areas of mathematics, engineering, biology, and sociology which had previously been considered unrelated. Among the most important participants (in addition to Wiener, Rosenbluth, Bateson, Mead, and von Neumann) were Heinz von Foerster, Kurt

Figure 11.11: **Margaret Mead (1901-1978) and Gregory Bateson (1904-1980). They used the feedback loops studied by Wiener to explain many aspects of human behavior. Bateson is considered to be one of the main founders of the discipline Biosemiotics, which considers information to be the central feature of living organisms.**

Lewin, Warren McCulloch and Walter Pitts. The Macy conferences were small and informal, with an emphasis on discussion as opposed to the presentation of formal papers. A stenographic record of the last five conferences has been published, edited by von Foerster. Transcripts of the discussions give a vivid picture of the enthusiastic and creative atmosphere of the meetings. The participants at the Macy Conferences perceived Cybernetics as a much-needed bridge between the natural sciences and the humanities. Hence their enthusiasm. Wiener's feedback loops and von Neumann's theory of games were used by anthropologists Mead and Bateson to explain many aspects of human behavior.

11.4 Microelectronics

The problem of unreliable vacuum tubes was solved in 1948 by John Bardeen, William Shockley and Walter Brattain of the Bell Telephone Laboratories. Application of quantum theory to solids had led to an understanding of the electronic properties of crystals. Like atoms, crystals were found to have allowed and forbidden energy levels.

The allowed energy levels for an electron in a crystal were known to form bands; i.e., some energy ranges with a quasi-continuum of allowed states (allowed bands), and other energy ranges with none (forbidden bands). The lowest allowed bands were occupied by electrons, while higher bands were empty. The highest filled band was called the valence band, and the lowest empty band was called the conduction band.

According to quantum theory, whenever the valence band of a crystal is only partly filled, the crystal is a conductor of electricity; but if the valence band is completely rilled with electrons, the crystal is an electrical insulator. (A completely filled band is analogous to a room so packed with people that none of them can move.)

In addition to explaining conductors and insulators, quantum theory yielded an understanding of semiconductors - crystals where the valence band is completely filled with electrons, but where the energy gap between the conduction band and the valence band is relatively small. For example, crystals of the elements silicon and germanium are semiconductors. For such a crystal, thermal energy is sometimes enough to lift an electron from the valence band to the conduction band.

Bardeen, Shockley and Brattain found ways to control the conductivity of germanium crystals by injecting electrons into the conduction band, or alternatively by removing electrons from the valence band. They could do this by forming junctions between crystals "doped" with appropriate impurities, and by injecting electrons with a special electrode. The semi-conducting crystals whose conductivity was controlled in this way could be used as electronic valves, in place of vacuum tubes.

By the 1960's, replacement of vacuum tubes by transistors in electronic computers had led not only to an enormous increase in reliability and a great reduction in cost, but also to an enormous increase in speed. It was found that the limiting factor in computer speed was the time needed for an electrical signal to propagate from one part of the central processing unit to another. Since electrical impulses propagate with the speed of light, this time is extremely small; but nevertheless, it is the limiting factor in the speed of electronic computers.

In order to reduce the propagation time, computer designers tried to make the central processing units very small; and the result was the development of integrated circuits and microelectronics. (Another motive for miniaturization of electronics came from the requirements of space exploration.)

Integrated circuits were developed, in which single circuit elements were not manufactured separately, but instead the whole circuit was made at one time. An integrated circuit is a multilayer sandwich-like structure, with conducting, resisting and insulating layers interspersed with layers of germanium or silicon, "doped" with appropriate impurities. At the start of the manufacturing process, an engineer makes a large drawing of each layer. For example, the drawing of a conducting layer would contain pathways which fill the role played by wires in a conventional circuit, while the remainder of the layer would consist of areas destined to be etched away by acid.

The next step is to reduce the size of the drawing and to multiply it photographically. The pattern of the layer is thus repeated many times, like the design on a piece of wallpaper. The multiplied and reduced drawing is then focused through a reversed microscope onto the surface to be etched. Successive layers are built up by evaporating or depositing thin films of the appropriate substances onto the surface of a silicon or germanium wafer. If the layer being made is to be conducting, the surface might consist of an extremely thin layer of copper, covered with a photosensitive layer called a "photoresist". On those portions of the surface receiving light from the pattern, the photoresist becomes insoluble, while on those areas not receiving light, the photoresist can be washed away.

The surface is then etched with acid, which removes the copper from those areas not protected by photoresist. Each successive layer of a wafer is made in this way, and finally the wafer is cut into tiny "chips", each of which corresponds to one unit of the wallpaper-like pattern. Although the area of a chip may be much smaller than a square centimeter, the chip can contain an extremely complex circuit.

In 1965, only four years after the first integrated circuits had been produced, Dr. Gordon E. Moore, one of the founders of Intel, made a famous prediction which has come to be known as "Moore's Law". He predicted that the number of transistors per integrated circuit would double every two years, and that this trend would continue through 1975. In fact, the general trend predicted by Moore has continued for a much longer time. Although the number of transistors per unit area has not continued to double every two years, the logic density (bits per unit area) has done so, and thus a modified version of Moore's law still holds today. How much longer the trend can continue remains to be seen. Physical limits to miniaturization of transistors of the present type will soon be reached; but there is hope that further miniaturization can be achieved through "quantum dot" technology, molecular switches, and autoassembly, as will be discussed in Chapter 8.

A typical programmable minicomputer or "microprocessor", manufactured in the 1970's, could have 30,000 circuit elements, all of which were contained on a single chip. By 1989, more than a million transistors were being placed on a single chip; and by 2000, the number reached 42,000,000. As a result of miniaturization and parallelization, the speed of computers rose exponentially. In 1960, the fastest computers could perform a hundred thousand elementary operations in a second. By 1970, the fastest computers took less than a second to perform a million such operations. In 1987, a massively parallel computer, with 566 parallel processors, called GFll was designed to perform 11 billion floating-point operations per second (flops). By 2002 the fastest computer performed 40 at teraflops, making use of 5120 parallel CPU's.

Computer disk storage has also undergone a remarkable development. In 1987, the magnetic disk storage being produced could store 20 million bits of information per square inch; and even higher densities could be achieved by optical storage devices. Storage density has until followed a law similar to Moore's law.

In the 1970's and 1980's, computer networks were set up linking machines in various parts of the world. It became possible (for example) for a scientist in Europe to perform a calculation interactively on a computer in the United States just as though the distant machine were in the same room; and two or more computers could be linked for performing large calculations. It also became possible to exchange programs, data, letters and manuscripts very rapidly through the computer networks.

The exchange of large quantities of information through computer networks was made easier by the introduction of fiber optics cables. By 1986, 250,000 miles of such cables had been installed in the United States. If a ray of light, propagating in a medium with a large refractive index, strikes the surface of the medium at a grazing angle, then the ray undergoes total internal reflection. This phenomenon is utilized in fiber optics: A light signal can propagate through a long, hairlike glass fiber, following the bends of the fiber without losing intensity because of total internal reflection. However, before fiber optics could be used for information transmission over long distances, a technological breakthrough in glass manufacture was needed, since the clearest glass available in 1940 was opaque in lengths more than 10 m. Through studies of the microscopic properties of glasses, the problem of absorption was overcome. By 1987, devices were being manufactured commercially that were capable of transmitting information through fiber-optic cables at the rate of 1.7 billion bits per second.

11.5 The history of the Internet and World Wide Web

The history of the Internet began in 1961, when Leonard Kleinrock, a student at MIT, submitted a proposal for Ph.D. thesis entitled "Information Flow in Large Communication Nets". In his statement of the problem, Kleinrock wrote: "The nets under consideration consist of nodes, connected to each other by links. The nodes receive, sort, store, and transmit messages that enter and leave via the links. The links consist of one-way channels, with fixed capacities. Among the typical systems which fit this description are the Post Office System, telegraph systems, and satellite communication systems." Kleinrock's theoretical treatment of package switching systems anticipated the construction of computer networks which would function on a principle analogous to a post office rather than a telephone exchange: In a telephone system, there is a direct connection between the sender and receiver of information. But in a package switching system, there is no such connection - only the addresses of the sender and receiver on the package of information, which makes its way from node to node until it reaches its destination.

Further contributions to the concept of package switching systems and distributed communications networks were made by J.C.R. Licklider and W. Clark of MIT in 1962, and by Paul Baran of the RAND corporation in 1964. Licklider visualized what he called a "Galactic Network", a globally interconnected network of computers which would allow social interactions and interchange of data and software throughout the world. The distributed computer communication network proposed by Baran was motivated by the desire to have a communication system that could survive a nuclear war. The Cold War had also provoked the foundation (in 1957) of the Advanced Research Projects Agency (ARPA) by the U.S. government as a response to the successful Russian satellite "Sputnik".

In 1969, a 4-node network was tested by ARPA. It connected computers at the University of California divisions at Los Angeles and Santa Barbara with computers at the Stanford Research Institute and the University of Utah. Describing this event, Leonard Kleinrock said in an interview: "We set up a telephone connection between us and the guys at SRI. We typed the L and we asked on the phone 'Do you see the L?' 'Yes we see the L', came the response. We typed the 0 and we asked 'Do you see the 0?' 'Yes we see the O.' Then we typed the G and the system crashed." The ARPANET (with 40 nodes) performed much better in 1972 at the Washington Hilton Hotel where the participants at a Conference on Computer Communications were invited to test it.

Although the creators of ARPANET visualized it as being used for long- distance computations involving several computers, they soon discovered that social interactions over the Internet would become equally important if not more so. An electronic mail system was introduced in the early 1970's, and in 1976 Queen Elizabeth II of the United Kingdom became one of the increasing number of e-mail users.

In September, 1973, Robert F. Kahn and Vinton Cerf presented the basic ideas of the Internet at a meeting of the International Network Working Group at the University Sussex in Brighton, England. Among these principles was the rule that the networks to be connected should not be changed internally. Another rule was that if a packet did not arrive at its destination, it would be retransmitted from its original source. No information was to be retained by the gateways used to connect networks; and finally there was to be no global control of the Internet at the operations level.

Computer networks devoted to academic applications were introduced in the 1970's and 1980's, both in England, the United States and Japan. The Joint Academic Network (JANET) in the U.K. had its counterpart in the National Science Foundation's network (NSFNET) in America and Japan's JUNET (Japan Unix Network). Internet traffic is approximately doubling each year,[2] and it is about to overtake voice communication in the volume of information transferred.

In March, 2011, there were more than two billion Internet users in the world. In North America they amounted to 78.3 % of the total population, in Europe 58.3 % and worldwide, 30.2 %. Another index that can give us an impression of the rate of growth of digital data

[2] In the period 1995-1996, the rate of increase was even faster - a doubling every four months

Table 11.1: **Historical total world Internet traffic (after Cisco Visual Networking Index Forecast). 1 terrabyte =1,000,000,000,000 bytes**

year	terabytes per month
1990	1
1991	2
1992	4
1993	10
1994	20
1995	170
1996	1,800
1997	5,000
1998	11,000
1999	26,000
2000	75,000
2001	175,000
2002	358,000
2003	681,000
2004	1,267,000
2005	2,055,000
2006	3,339,000
2007	5,219,000
2008	7,639,000
2009	10,676,000
2010	14,984,000

generation and exchange is the "digital universe", which is defined to be the total volume of digital information that human information technology creates and duplicates in a year. In 2011 the digital universe reached 1.2 zettabytes, and it is projected to quadruple by 2015. A zettabyte is 10^{21} bytes, an almost unimaginable number, equivalent to the information contained in a thousand trillion books, enough books to make a pile that would stretch twenty billion kilometers.

11.6 Self-reinforcing information accumulation

Humans have been living on the earth for roughly two million years (more or less, depending on where one draws the line between our human and prehuman ancestors, Table 6.1). During almost all of this,time, our ancestors lived by hunting and food-gathering. They were not at all numerous, and did not stand out conspicuously from other animals. Then, suddenly, during the brief space of ten thousand years, our species exploded in numbers from a few million to seven billion (Figure 6.1), populating all parts of the earth, and even setting foot on the moon. This population explosion, which is still going on, has been the result of dramatic cultural changes. Genetically we are almost identical with our hunter-gatherer ancestors, who lived ten thousand years ago, but cultural evolution has changed our way of life beyond recognition.

Beginning with the development of speech, human cultural evolution began to accelerate. It started to move faster with the agricultural revolution, and faster still with the invention of writing and printing. Finally, modern science has accelerated the rate of social and cultural change to a completely unprecedented speed.

The growth of modern science is accelerating because knowledge feeds on itself. A new idea or a new development may lead to several other innovations, which can in turn start an avalanche of change. For example, the quantum theory of atomic structure led to the invention of transistors, which made high-speed digital computers possible. Computers have not only produced further developments in quantum theory; they have also revolutionized many other fields.

The self-reinforcing accumulation of knowledge - the information explosion - which characterizes modern human society is reflected not only in an explosively-growing global population, but also in the number of scientific articles published, which doubles roughly every ten years. Another example is Moore's law - the doubling of the information density of integrated circuits every two years. Yet another example is the explosive growth of Internet traffic shown in Table 7.1.

The Internet itself is the culmination of a trend towards increasing societal information exchange - the formation of a collective human consciousness. This collective consciousness preserves the observations of millions of eyes, the experiments of millions of hands, the thoughts of millions of brains; and it does not die when the individual dies.

11.7 The history of Wikipedia

Here is an excerpt from Wikipedia's article on the history of Wikipedia:

Wikipedia began with its first edit on 15 January 2001, two days after the domain was registered by Jimmy Wales and Larry Sanger. Its technological and conceptual underpinnings predate this; the earliest known proposal for an online encyclopedia was made by Rick Gates in 1993, and the concept of a free-as-in-freedom online encyclopedia (as distinct from mere open source) was proposed by Richard Stallman in December 2000.

Crucially, Stallman's concept specifically included the idea that no central organization should control editing. This characteristic greatly contrasted with contemporary digital encyclopedias such as Microsoft Encarta, Encyclopædia Britannica, and even Bomis's Nupedia, which was Wikipedia's direct prede-

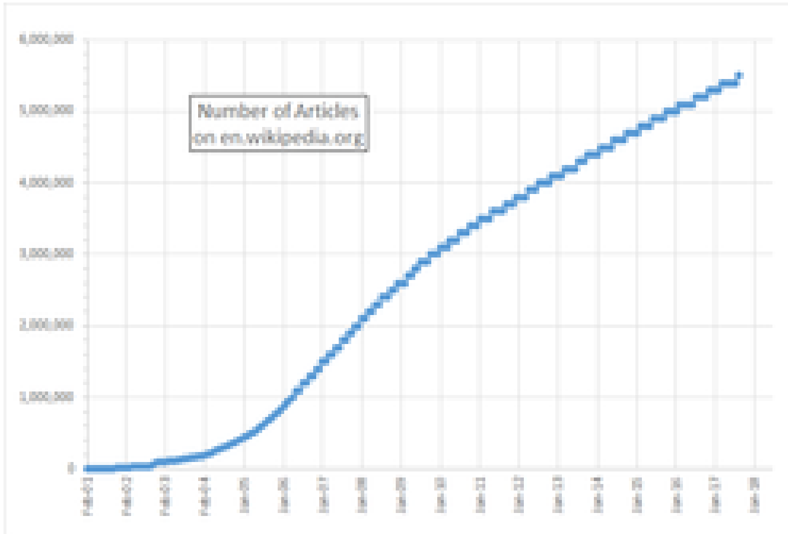

Figure 11.12: **The English edition of Wikipedia has grown to 6,074,878 articles, equivalent to over 2,600 print volumes of the Encyclopædia Britannica. Including all language editions, Wikipedia has over 53 million articles as of 2020, equivalent to nearly 20,000 print volumes.**

cessor. In 2001, the license for Nupedia was changed to GFDL, and Wales and Sanger launched Wikipedia using the concept and technology of a wiki pioneered in 1995 by Ward Cunningham. Initially, Wikipedia was intended to complement Nupedia, an online encyclopedia project edited solely by experts, by providing additional draft articles and ideas for it. In practice, Wikipedia quickly overtook Nupedia, becoming a global project in multiple languages and inspiring a wide range of other online reference projects.

According to Alexa Internet, as of December 2019, Wikipedia is the world's ninth most popular website in terms of global internet engagement. Wikipedia's worldwide monthly readership is approximately 495 million. Worldwide in September 2018, WMF Labs tallied 15.5 billion page views for the month. According to comScore, Wikipedia receives over 117 million monthly unique visitors from the United States alone.

Figure 11.13: **Jimmy Wales (born in 1966), cofounder of Wikipedia. He is seen here in 2019.**

11.8 The history of Google

Here is an excerpt from Wikipedia's article on the history of Google:

The Google company was officially launched in 1998 by Larry Page and Sergey Brin to market Google Search, which has become the most used web-based search engine. Larry Page and Sergey Brin, students at Stanford University in California, developed a search algorithm at first known as "BackRub" in 1996, with the help of Scott Hassan and Alan Steremberg. The search engine soon proved successful and the expanding company moved several times, finally settling at Mountain View in 2003. This marked a phase of rapid growth, with the company making its initial public offering in 2004 and quickly becoming one of the world's largest media companies. The company launched Google News in 2002, Gmail in 2004, Google Maps in 2005, Google Chrome in 2008, and the social network known as Google+ in 2011 (which was shut down in April 2019), in addition to many other products. In 2015, Google became the main subsidiary of the holding company Alphabet Inc.

The search engine went through a lot of updates in attempts to combat search engine optimization abuse, provide dynamic updating of results, and make the indexing system rapid and flexible. Search results started to be personalized in 2005, and later Google Suggest autocompletion was introduced. From 2007, Universal Search provided all types of content, not just text content, in search results.

Google has engaged in partnerships with NASA, AOL, Sun Microsystems, News Corporation, Sky UK, and others. The company set up a charitable offshoot, Google.org, in 2005. Google was involved in a 2019 legal dispute in the US over a court order to disclose URLs and search strings, and has been the subject of tax avoidance investigations in the UK.

The name Google is a misspelling of Googol, the number 1 followed by 100 zeros, which was picked to signify that the search engine was intended to provide large quantities of information.

Google has its origins in "BackRub", a research project that was begun in 1996 by Larry Page and Sergey Brin when they were both PhD students at Stanford University in Stanford, California. The project initially involved an unofficial "third founder", Scott Hassan, the lead programmer who wrote much of the code for the original Google Search engine, but he left before Google was officially founded as a company; Hassan went on to pursue a career in robotics and founded the company Willow Garage in 2006.

In the search of a dissertation theme, Page had been considering among other things exploring the mathematical properties of the World Wide Web, understanding its link structure as a huge graph. His supervisor, Terry Winograd, encouraged him to pick this idea (which Page later recalled as "the best advice I ever got") and Page focused on the problem of finding out which web

Figure 11.14: **Larry Page and Sergey Brin in 2003.**

pages link to a given page, based on the consideration that the number and nature of such backlinks was valuable information about that page (with the role of citations in academic publishing in mind). Page told his ideas to Hassan, who began writing the code to implement Page's ideas...

Convinced that the pages with the most links to them from other highly relevant Web pages must be the most relevant pages associated with the search, Page and Brin tested their thesis as part of their studies, and laid the foundation for their search engine. The first version of Google was released in August 1996 on the Stanford website. It used nearly half of Stanford's entire network bandwidth.

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Chapter 12

PEACE EDUCATION

12.1 Traditional school systems aim at indoctrination in nationalism

School systems have traditionally aimed at producing nationalism in their students. Within the Roman Empire, students were taught the motto "Dulce et decorum est pro patria mori" (It is sweet and noble to die for one's country). In the era when the sun never set on the British Empire, schoolboys in England were taught the same motto, and the Roman Empire was held up as an ideal. One said the "The battle of Waterloo was won on the playing fields of Eton".

If the reader will excuse a personal note, I can remember attending elementary schools in the United States where every morning we pledged allegiance to the US flag. With hands on our hearts, we students repeated "I pledge allegiance to the flag of the United States of America, and to the Republic for which it stands - one nation, indivisible, with liberty and justice for all." I believe that with small changes in wording, this ceremony is repeated every day today in all American schools.

I can also remember, later on, my great surprise in learning that many of the wars conducted by the United States have been aggressive and unjust. There had been no hint of that in the history lessons of US schools. I believe that the situation is the same in every country. History lessons are an indoctrination in nationalism. In history, as it is taught, one's own country is always heroic and in the right.

Today, in an era of instantaneous communication, global economic and cultural interdependence, and all-destroying modern weapons, the absolutely sovereign nation-state has become a dangerous anachronism. Blind nationalism too, has become a dangerous anachronism. Therefore we need to reform our school systems, but the process of making the needed changes is slowed the habits of teachers and administrators, and by shelves full of nationalistic history books.

12.2 The urgent need for peace education

Since modern war has become prohibitively dangerous, there is an urgent need for peace education. Why do we pay colossal sums for war, which we know is the source of so much human suffering, and which threatens to destroy human civilization? Why not instead support peace and peace education?

In this section, we will see that many groups and individuals are already working for this goal. With even a little more support, they would be much more effective.

12.3 The growth of global consciousness

Besides a humane, democratic and just framework of international law and governance, we urgently need a new global ethic, - an ethic where loyalty to family, community and nation will be supplemented by a strong sense of the brotherhood of all humans, regardless of race, religion or nationality. Schiller expressed this feeling in his "Ode to Joy", a part of which is the text of Beethoven's Ninth Symphony. Hearing Beethoven's music and Schiller's words, most of us experience an emotion of resonance and unity with the message: All humans are brothers and sisters - not just some - all! It is almost a national anthem of humanity. The feelings that the music and words provoke are similar to patriotism, but broader. It is this sense of a universal human family that we need to cultivate in education, in the mass media, and in religion. We already appreciate music, art and literature from the entire world, and scientific achievements are shared by all, regardless of their country of origin. We need to develop this principle of universal humanism so that it will become the cornerstone of a new ethic.

12.4 Reformed teaching of history

Educational reforms are urgently needed, particularly in the teaching of history. As it is taught today, history is a chronicle of power struggles and war, told from a biased national standpoint. Our own race or religion is superior; our own country is always heroic and in the right.

We urgently need to replace this indoctrination in chauvinism by a reformed view of history, where the slow development of human culture is described, giving adequate credit to all who have contributed. Our modern civilization is built on the achievements of many ancient cultures. China, Japan, India, Mesopotamia, Egypt, Greece, the Islamic world, Christian Europe, and the Jewish intellectual traditions all have contributed. Potatoes, corn, squash, vanilla, chocolate, chili peppers, pineapples, quinine, etc. are gifts from the American Indians. Human culture, gradually built up over thousands of years by the patient work of millions of hands and minds, should be presented as a precious heritage - far too precious to be risked in a thermonuclear war.

The teaching of history should also focus on the times and places where good government and internal peace have been achieved, and the methods by which this has been accomplished. Students should be encouraged to think about what is needed if we are to apply the same methods to the world as a whole. In particular, the histories of successful federations should be studied, for example the Hanseatic League, the Universal Postal Union, the federal governments of Australia, Brazil, Germany, Switzerland, the United States, Canada, and so on. The recent history of the European Union provides another extremely important example. Not only the successes, but also the problems of federations should be studied in the light of the principle of subsidiarity[1]. The essential features of federations should be clarified[2], as well as the reasons why weaker forms of union have proved to be unsuccessful.

12.5 Reformed education of economists and businessmen

The education of economists and businessmen needs to face the problems of global poverty - the painful contrast between the affluence and wastefulness of the industrial North and the malnutrition, disease and illiteracy endemic in the South. Students of economics and business must look for the roots of poverty not only in population growth and war, but also in the history of colonialism and neocolonialism, and in defects in global financial institutions and trade agreements. They must be encouraged to formulate proposals for the correction of North-South economic inequality.

The economic impact of war and preparation for war should be included in the training of economists. Both direct and indirect costs should be studied. An example of an indirect cost of war is the effect of unimaginably enormous military budgets in reducing the amount of money available for solving the serious problems facing the world today.

12.6 Law for a united world

Law students should be made aware of the importance of international law. They should be familiar with its history, starting with Grotius and the Law of the Sea. They should know the histories of the International Court of Justice and the Nuremberg Principles. They should study the United Nations Charter (especially the articles making war illegal) and the Universal Declaration of Human Rights, as well as the Rome Treaty and the foundation of the International Criminal Court. They should be made aware of a deficiency in the present United Nations - the lack of a legislature with the power to make laws that are binding on individuals.

[1]The principle of subsidiarity states that within a federation, decisions should be taken at the lowest level at which there are no important externalities. Thus, for example, decisions affecting air quality within Europe should be taken in Bruxelles because winds blow freely across national boundaries, but decisions affecting only the local environment should be taken locally.

[2]One of the most important of these features is that federations have the power to make and enforce laws that are binding on individuals, rather than trying to coerce their member states.

Students of law should be familiar with all of the details of the World Court's historic Advisory Opinion on Nuclear Weapons, a decision that make the use or threat of use of nuclear weapons illegal. They should also study the Hague and Geneva Conventions, and the various international treaties related to nuclear, chemical and biological weapons. The relationship between the laws of the European Union and those of its member states should be given high importance. The decision by the British Parliament that the laws of the EU take precedence over British law should be a part of the curriculum.

12.7 Teaching global ethics

Professors of theology should emphasize three absolutely central components of religious ethics: the duty to love and forgive one's enemies, the prohibition against killing, and the concept of universal human brotherhood. They should make their students conscious of a responsibility to give sermons that are relevant to the major political problems of the modern world, and especially to relate the three ethical principles just mentioned to the problem of war. Students of theology should be made conscious of their responsibility to soften the boundaries between ethnic groups, to contribute to interreligious understanding, and to make marriage across racial and religious boundaries more easy and frequent.

12.8 The social responsibility of scientists

In teaching science too, reforms are needed. Graduates in science and engineering should be conscious of their responsibilities. They must resolve never to use their education in the service of war, nor for the production of weapons, nor in any way that might be harmful to society or to the environment.

Science and engineering students ought to have some knowledge of the history and social impact of science. They could be given a course on the history of scientific ideas; but in connection with modern historical developments such as the industrial revolution, the global population explosion, the development of nuclear weapons, genetic engineering, and information technology, some discussion of social impact of science could be introduced. One might hope to build up in science and engineering students an understanding of the way in which their own work is related to the general welfare of humankind, and a sense of individual social and ethical responsibility. These elements are needed in science education if rapid technological progress is to be beneficial to society rather than harmful.

The changes just mentioned in the specialized lawyers, theologians, scientists and engineers should have a counterpart in elementary education. The basic facts about peace and war should be communicated to children in simple language, and related to the everyday experiences of children. Teachers' training colleges ought to discuss with their student-teachers the methods that can be used to make peace education a part of the curriculum at various levels, and how it can be related to familiar concepts. They should also discuss the degree to which the painful realities of war can be explained to children of various ages without creating an undesirable amount of anxiety.

Peace education can be made a part of the curriculum of elementary schools through (for example) theme days or theme weeks in which the whole school participates. This method has been used successfully in many European schools. During the theme days the children have been encouraged to produce essays, poems and drawings illustrating the difference between peace and war, and between negative peace and positive peace[3]. Another activity has been to list words inspired by the concept "peace", rapidly and by free association, and to do the same for the concept "war". Drama has also been used successfully in elementary school peace education, and films have proved to be another useful teaching aid.

The problems of reducing global inequalities, of protecting human rights, and of achieving a war-free world can be introduced into grade school courses in history, geography, religion and civics. The curriculum of these courses is frequently revised, and advocates of peace education can take curriculum revisions as opportunities to introduce much-needed reforms that will make the students more international in their outlook. The argument (a true one) should be that changes in the direction of peace education will make students better prepared for a future in which peace will be a central issue and in which they will interact with people of other nations to a much greater extent than was the case in previous generations. The same can be said for curriculum revisions at the university level.

12.9 Large nations compared with global government

The problem of achieving internal peace over a large geographical area is not insoluble. It has already been solved. There exist today many nations or regions within each of which there is internal peace, and some of these are so large that they are almost worlds in themselves. One thinks of China, India, Brazil, Australia, the Russian Federation, the United States, and the European Union. Many of these enormous societies contain a variety of ethnic groups, a variety of religions and a variety of languages, as well as striking contrasts between wealth and poverty. If these great land areas have been forged into peaceful and cooperative societies, cannot the same methods of government be applied globally?

But what are the methods that nations use to achieve internal peace? Firstly, every true government needs to have the power to make and enforce laws that are binding on individual citizens. Secondly the power of taxation is a necessity. These two requirements of every true government have already been mentioned; but there is a third point that still remains to be discussed:

Within their own territories, almost all nations have more military power than any of their subunits. For example, the US Army is more powerful than the State Militia of Illinois. This unbalance of power contributes to the stability of the Federal Government of

[3]Negative peace is merely the absence of war. In positive peace, neighboring nations are actively engaged in common projects of mutual benefit, in cultural exchanges, in trade, in exchanges of students and so on.

the United States. When the FBI wanted to arrest Al Capone, it did not have to bomb Chicago. Agents just went into the city and arrested the gangster. Even if Capone had been enormously popular in Illinois, the government of the state would have realized in advance that it had no chance of resisting the US Federal Government, and it still would have allowed the "Feds" to make their arrest. Similar considerations hold for almost all nations within which there is internal peace. It is true that there are some nations within which subnational groups have more power than the national government, but these are frequently characterized by civil wars.

Of the large land areas within which internal peace has been achieved, the European Union differs from the others because its member states still maintain powerful armies. The EU forms a realistic model for what can be achieved globally in the near future by reforming and strengthening the United Nations. In the distant future, however, we can imagine a time when a world federal authority will have much more power than any of its member states, and when national armies will have only the size needed to maintain local order.

Today there is a pressing need to enlarge the size of the political unit from the nation-state to the entire world. The need to do so results from the terrible dangers of modern weapons and from global economic interdependence. The progress of science has created this need, but science has also given us the means to enlarge the political unit: Our almost miraculous modern communications media, if properly used, have the power to weld all of humankind into a single supportive and cooperative society.

12.10 Culture, education and human solidarity

Cultural and educational activities have a small ecological footprint, and therefore are more sustainable than pollution-producing, fossil-fuel-using jobs in industry. Furthermore, since culture and knowledge are shared among all nations, work in culture and education leads societies naturally towards internationalism and peace.

Economies based on a high level of consumption of material goods are unsustainable and will have to be abandoned by a future world that renounces the use of fossil fuels in order to avoid catastrophic climate change, a world where non-renewable resources such as metals will become increasingly rare and expensive. How then can full employment be maintained?

The creation of renewable energy infrastructure will provide work for a large number of people; but in addition, sustainable economies of the future will need to shift many workers from jobs in industry to jobs in the service sector. Within the service sector, jobs in culture and education are particularly valuable because they will help to avoid the disastrous wars that are currently producing enormous human suffering and millions of refugees, wars that threaten to escalate into an all-destroying global thermonuclear war.[4]

[4]http://www.fredsakademiet.dk/library/need.pdf
http://eruditio.worldacademy.org/issue-5/article/urgent-need-renewable-energy

Figure 12.1: **Cultural exchanges lead to human solidarity** (Public domain)

Human nature has two sides: It has a dark side, to which nationalism and militarism appeal; but our species also has a genius for cooperation, which we can see in the growth of culture. Our modern civilization has been built up by means of a worldwide exchange of ideas and inventions. It is built on the achievements of many ancient cultures. China, Japan, India, Mesopotamia, Egypt, Greece, the Islamic world, Christian Europe, and the Jewish intellectual traditions all have contributed. Potatoes, corn, squash, vanilla, chocolate, chilli peppers, and quinine are gifts from the American Indians.[5]

We need to reform our educational systems, particularly the teaching of history. As it is taught today, history is a chronicle of power struggles and war, told from a biased national standpoint. We are taught that our own country is always heroic and in the right. We urgently need to replace this indoctrination in chauvinism by a reformed view of history, where the slow development of human culture is described, giving credit to all who have contributed. When we teach history, it should not be about power struggles. It should be about how human culture was gradually built up over thousands of years by the patient work of millions of hands and minds. Our common global culture, the music, science, literature and art that all of us share, should be presented as a precious heritage - far too precious to be risked in a thermonuclear war.

We have to extend our loyalty to the whole of the human race, and to work for a world not only free from nuclear weapons, but free from war. A war-free world is not utopian but very practical, and not only practical but necessary. It is something that we can achieve and must achieve. Today their are large regions, such as the European Union, where war would be inconceivable. What is needed is to extend these.

Nor is a truly sustainable economic system utopian or impossible. To achieve it, we

[5]http://eruditio.worldacademy.org/article/evolution-cooperation

should begin by shifting jobs to the creation of renewable energy infrastructure, and to the fields of culture and education. By so doing we will support human solidarity and avoid the twin disasters of catastrophic war and climate change.

12.11 The Danish National Group of Pugwash Conferences

In March, 1954, the US tested a hydrogen bomb at the Bikini Atoll in the Pacific Ocean. It was 1000 times more powerful than the Hiroshima bomb. The Japanese fishing boat, Lucky Dragon, was 130 kilometers from the Bikini explosion, but radioactive fallout from the test killed one crew member and made all the others seriously ill.

Concerned about the effects of a large-scale war fought with such bombs, or even larger ones, Albert Einstein and Bertrand Russell published a manifesto containing the words: "Here then is the problem that we present to you, stark and dreadful and inescapable: Shall we put an end to the human race, or shall mankind renounce war?... There lies before us, if we choose, continual progress in happiness, knowledge and wisdom. Shall we, instead, choose death because we cannot forget our quarrels? We appeal as human beings to human beings: Remember your humanity, and forget the rest. If you can do so, the way lies open to a new Paradise; if you cannot, there lies before you the risk of universal death."

The Russell-Einstein Manifesto called for a meeting of scientists from both sides of the Cold War to try to minimize the danger of a thermonuclear conflict. The first meeting took place in 1957 at the summer home of the Canadian philanthropist Cyrus Eaton at the small village of Pugwash, Nova Scotia.

From this small beginning, a series of conferences developed, in which scientists, especially physicists, attempted to work for peace, and tried to address urgent problems related to science. These conferences were called Pugwash Conferences on Science and World Affairs, taking their name from the small village in Nova Scotia where the first meeting was held. From the start, the main aim of the meetings was to reduce the danger that civilization would be destroyed in a thermonuclear war.

Many countries have local Pugwash groups, and the Danish National Pugwash Group is one of these. Our activities include conferences at the Danish Parliament, aimed at influencing decision-makers, but other activities are aimed influencing public opinion. Peace education activities include the award of student peace prizes on United Nations Day.

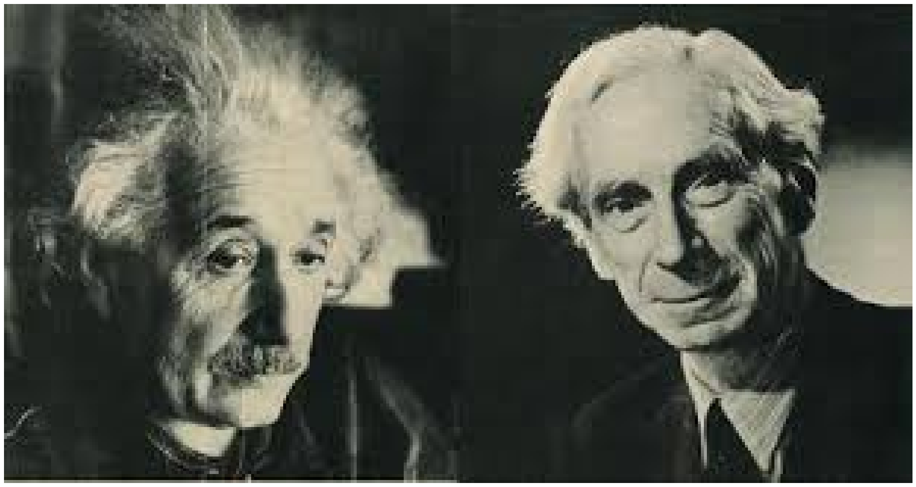

Figure 12.2: **The Russell-Einstein Manifesto: "Shall we put an end to the human race, or shall mankind renounce war?"**(Pugwash Conferences)

12.12 United Nations Day Student Peace Prizes

In collaboration with the Danish Peace Academy, and with the help of the Hermod Lannung Foundation the Danish National Group of Pugwash Conferences on Science and World Affairs has offered prizes each year to students at 10 Danish gymnasiums for projects related to global problems and their solutions and to the United Nations.

These projects are essays, dramatic sketches, videos, websites, posters, etc., and they were judged on UN Day, before large audiences of students. The background for this project is as follows: In 2007, in collaboration with several other NGO's, we arranged a visit to Copenhagen by Dr. Tadatoshi Akiba, the Mayor of Hiroshima. In connection with his visit, we arranged a Peace Education Conference at the University of Copenhagen.

In connection with Dr. Akiba's visit, we also arranged a day of peace education at Copenhagen's Open Gymnasium. About 15 people from various branches of Denmark's peace movement arrived at the gymnasium at 7.00 a.m., and between 8.00 and 10.00 they talked to 15 groups of about 25-50 students about topics related to peace. At 10.30, all 500 students assembled in a large hall, where Dr. Akiba gave an address on abolition of nuclear weapons. A chorus from the gymnasium sang, and finally there was a panel discussion.

The students were extremely enthusiastic about the whole program. The success of our 2007 effort made us want to do something similar in 2008, and perhaps to broaden the scope. Therefore we wrote to the Minister of Education, and proposed that October 24, United Nations Day, should be a theme day in all Danish schools and gymnasiums, a day devoted to the discussion of global problems and their solutions. We received the very kind reply. The Minister said that he thought our idea was a good one, but that he did not have the power to dictate the curricula to schools. We needed to contact the individual schools, gymnasiums and municipalities.

In the autumn of 2008 we arranged a United Nations Day program on October 24 at

Figure 12.3: **A painting representing the work of the United Nations. It won first prize at a UN Day Student Peace Prize competition.** (Danish National Pugwash Group)

Sankt Annæ Gymnasium with the cooperation of Nørre Gymnasium. We offered prizes to drama students at the two gymnasiums for the best peace-related dramatic sketch, a condition being that the sketches should be performed and judged before a large audience. Our judges were the famous actress Mia Luhne, Johan Olsen, the lead singer of a popular rock group, and the dramatist Steen Haakon Hansen. The students' sketches and the judges speeches about the meaning of peace were very strong and moving. Everyone was very enthusiastic about the day. The judges have said that they would be willing to work with us again on peace-related cultural events.

Our successes in 2007 and 2008 have made us wish to continue and possibly expand the idea of making United Nations Day a theme day in Danish schools and gymnasiums, a day for discussion of global problems and their solutions, with special emphasis on the role of the United Nations. The Hermod Lannung Foundation supported our project for extending this idea to 10 Danish gymnasiums from 2010 until the present.

12.13 The Grundtvigian Peoples' Colleges

A unique feature of the Danish educational system is the adult education that is available at about a hundred Folkehøjskole (Peoples' Colleges). This tradition of adult education dates back to the Danish poet-bishop N.F.S. Grundtvig (1783-1872). Besides writing more than half of the hymns presently used in Danish churches, Grundtvig also introduced farmers' cooperatives into Denmark and founded a system of adult education.

At the time when Grundtvig lived, the Industrial Revolution had already transformed England into a country that exported manufactured goods but was unable to feed itself because of its large population. In this situation, Denmark began a prosperous trade, exporting high quality agricultural produce to England (for example dairy products, bacon, and so on). Grundtvig realized that it would be to the advantage of small-scale Danish farmers to process and export these products themselves, thus avoiding losing a part of their profits to large land-owners or other middlemen who might do the processing and exporting for them. He organized the small farmers into cooperatives, and in order to give the farmers enough knowledge and confidence to run the cooperatives, Grundtvig created a system of adult education: the Peoples' Colleges. The cooperatives and the adult education system contributed strongly to making Denmark a prosperous and democratic country.

Of the hundred or so Grundtvigian Peoples' Colleges exiting today, about forty offer peace education as a subject. An example of such a peace education course was the two-week summer school "Towards a Non-violent Society", held at the International College in Elsinore during the summer of 1985. Since it was supported not only by the students' fees but also by a government subsidy, the summer school was able to pay the travel and living expenses for lecturers who came from many parts of the world.

Among the stars of the summer school were former US Governor Harold Stassen, the only living person who had signed the UN Charter; the famous Cambridge University ethologist, Professor Robert Hinde; Professor Suman Khana from India, an expert on non-violence and Gandhi; Sister George, a Catholic nun from Jerusalem, who spoke 12 languages during the course of her daily work and who was an expert on the conflicts of the Middle East; and Meta Ditzel, a member of the Danish Parliament who advocated legislation to make excessively violent videos less easily available to children. Other lectures were given by representatives of Amnesty International and the Center for Rehabilitation of Torture Victims.

In discussing Danish peace education initiatives, we must not fail to mention Holger Terp's enormous and popular Danish Peace Academy website[6]. Despite serious health problems, which include almost complete loss of vision and multiple heart bypass operations, Holger Terp singlehandedly established a unique website devoted to peace education. The Danish Peace Academy website contains more than 99,000 files in Danish, English and German. The website is visited by many thousands of students from around the world.

12.14 The World Conference of Religions for Peace

Other powerful voices for peace have been raised by the World Conference of Religions for Peace, which met for the first time in October 1970 in Kyoto, Japan.[7] At this meeting, more than 1000 religious leaders gathered to discuss the grave dangers posed by modern

[6] www.fredsakademiet.dk

[7] Subsequent World Assemblies of the WCRP have been held in Louvain, Belgium, (1974); Princeton New Jersey, (1979); Nairobi, Kenya, (1984); Melbourne, Australia, (1989); Riva del Garde, Italy, (1994); and Amman, Jordan, (1999).

war. Among them were representatives of the Baha'i, Mahayana and Trevada Buddhists, Protestants, Roman Catholics, Orthodox Christians, Confucians, representatives of several streams of Hinduism, a number of communities of indigenous faith, Shiite and Sunni Muslims, Jains, Reform Jews, Shintos, Sikhs, Zoroastrians, and representatives of a number of new religions.

The WCRP sponsors many projects related to conflict resolution, the world's children, development, disarmament and security, human rights, and peace education. For example, in the field of peace education, WCRP sponsors a project in Israel called "Common Values/Different Sources" which brings together Jews, Muslims and Christians to study sacred texts together in search of shared values, eventually resulting in a book for classroom use. In England and Germany, another WCRP project analyzes school textbooks' treatment of religious traditions that are foreign to the books' intended audiences.

Dr. Edy Korthals Altes, a former Ambassador of the Netherlands to Poland and Spain and an Honorary President of the World Conference of Religions for Peace, has expressed his vision of our current global situation in the following words: "We need a new concept of security. The old concept dates back to the Romans who said 'If you want peace, prepare for war.' The new concept I would propose is exactly the opposite, 'If you want peace, prepare for peace.' While this may sound simplistic, it is difficult to put into practice since the application of justice and solidarity in international political and economic relations requires sacrifices from 'those who have.' I would give three reasons why the old concept of 'security' is no longer valid: a) The extreme vulnerability of modern society; b) The tremendous destructive power of modern arms and terrorism; c) The interdependence between nations. These three elements are closely interconnected. It is therefore imperative to apply justice and solidarity in our international relations. If not, disaster looms!"

Dr. Altes feels that economic reforms are needed if global peace is to be achieved. "Not only economic justice is involved", he writes, "but also political justice. A clear example of which is the current situation in the Middle East. There must also be justice in the economic world situation in which 1/5 of the world population enjoys a high standard of living while 1/5 lives in terrible poverty, millions dying every year from hunger. This 'North South gap' is increasing!"

Discussing "myths that underlie our present economic system", he points to

1. "The notion that each person has unlimited material needs. We are told to 'consume more' which is totally contrary to any religion. What is more, it is a self-defeating program that is contrary to humanity in general. The New Testament is clear 'you shall not live on bread alone.' Our deeper needs are not for material goods but for inner growth."

2. "Unlimited growth. The economy, my firm, my salary should all grow. In a finite planet, this is total nonsense. This maxim of growth has brought about great ecological damage."

3. Idolatry of the Free Market. I am in favor of a free market, but one that is set in the context of social and human conditions. We need to apply means to avoid the 'law

of the jungle' in the market place."

No enumeration of religious voices raised in the cause of peace would be complete without mention of the Religious Society of Friends (Quakers), all of whom refuse to give any support whatever to the institution of war. Although they are fundamentally opposed to war as being completely contrary to Christian ethics, the Quakers are active in caring for the victims of war, and in 1947 the American Friends Service Committee and the Friends Service Council were jointly awarded the Nobel Peace Prize.

The non-violence of Mahatma Gandhi, Martin Luther King and Nelson Mandela, the writings of the Dalai Lama, the messages of Pope John Paul II and other popes, the anti-war convictions of the Quakers, and the many projects of the World Conference of Religions for Peace all illustrate the potentialities of the world's religions as powerful forces for mobilizing public opinion in the cause of peace. One hopes that the voice of religion in this cause will become still more powerful in the future. Each week, all over the world, congregations assemble and are addressed by their leaders on ethical issues. But all too often there is no mention of the astonishing and shameful contradiction between the institution of war (especially the doctrine of "massive retaliation"), and the principle of universal human brotherhood, loving and forgiving one's enemies, and returning good for evil. At a moment of history when the continued survival of civilization is in doubt because of the incompatibility of war with the existence of thermonuclear weapons, our religious leaders ought to use their enormous influence to help to solve the problem of war, which is after all an ethical problem. In this way, religion can become part of the cure of a mortal social illness rather than part of the disease - part of the answer rather than of part of the problem.

12.15 The Hiroshima Peace Committee and the last remaining hibakushas

In Japanese the survivors of injuries from the nuclear bombing of Hiroshima and Nagasaki are called "hibakushas". Over the years, the Soka Gakkai Hiroshima Peace Committee has published many books containing their testimonies. The most recent of these books, "A Silence Broken", contains the testimonies of 14 men, now all in their late 70's or in their 80's, who are among the last few remaining hibakushas. All 14 of these men have kept silent until now because of the prejudices against hibakushas in Japan, where they and their children are thought to be unsuitable as marriage partners because of the effects of radiation. But now, for various reasons, they have chosen to break their silence. Many have chosen to speak now because of the Fukushima disaster.

The testimonies of the hibakushas give a vivid picture of the hell-like horrors of the nuclear attack on the civilian population of Hiroshima, both in the short term and in the long term. For example, Shigeru Nonoyama, who was 15 at the time of the attack, says: "People crawling out from crumbled houses started to flee. We decided to escape to a safe place on the hill. We saw people with melted ears stuck to their cheeks, chins glued to their shoulders, heads facing in awkward positions, arms stuck to bodies, five fingers joined together and grab nothing. Those were the people fleeing. Not merely a hundred or two, The whole town was in chaos."

"I saw the noodle shop's wife leg was caught under a fallen pole, and a fire was approaching. She was screaming, 'Help me!Help me!' There were no soldiers, no firefighters. I later heard that her husband had cut off his wife's leg with a hatchet to save her."

"Each and every scene was hell itself. I couldn't tell the difference between the men and the women. Everybody had scorched hair, burned hair, and terrible burns. I thought I saw a doll floating in a fire cistern, but it was a baby. A wife trapped under her fallen house was crying, 'Dear, please help me, help me!' Her husband had no choice but to leave her in tears."

12.16 The Catholic Church

An outstanding example of religious leadership in addressing global problems was given by H.H. Pope John Paul II. In his Christmas address on 25 December, 2002, the Pope said that efforts for peace were urgently needed "in the Middle East, to extinguish the ominous smouldering of a conflict which, with the joint efforts of all, can be avoided."

Pope John Paul II was not an exception among the Roman Catholic Popes of the 20th century. All of them have spoken strongly against the institution of war. Especially notable are H.H. Pope Paul IV who made a one-day visit to the United Nations where his speech included the words "no more war, war never again", and H.H. Pope John XXIII, author of the eloquent encyclical, *Pacem in Terris*. One can think also of the Ecumenical Council Vatican II, which denounced the arms race as an "utterly treacherous trap for humanity", questioned the method of deterrence as a safe way to preserve a steady peace, and condemned war as a "crime against God and man himself".

In his Apostolic Exhortation, "Evangelii Gaudium", Pope Francis said: "In our time humanity is experiencing a turning-point in its history, as we can see from the advances being made in so many fields. We can only praise the steps being taken to improve people's welfare in areas such as health care, education and communications. At the same time we have to remember that the majority of our contemporaries are barely living from day to day, with dire consequences. A number of diseases are spreading. The hearts of many people are gripped by fear and desperation, even in the so-called rich countries. The joy of living frequently fades, lack of respect for others and violence are on the rise, and inequality is increasingly evident. It is a struggle to live and, often, to live with precious little dignity."

"This epochal change has been set in motion by the enormous qualitative, quantitative, rapid and cumulative advances occurring in the sciences and in technology, and by their instant application in different areas of nature and of life. We are in an age of knowledge and information, which has led to new and often anonymous kinds of power."

"Just as the commandment 'Thou shalt not kill' sets a clear limit in order to safeguard the value of human life, today we also have to say 'thou shalt not' to an economy of exclusion and inequality. Such an economy kills. How can it be that it is not a news item when an elderly homeless person dies of exposure, but it is news when the stock market loses two points? This is a case of exclusion. Can we continue to stand by when food is thrown away while people are starving? This is a case of inequality. Today everything comes under the laws of competition and the survival of the fittest, where the powerful feed upon the powerless. As a consequence, masses of people find themselves excluded and marginalized: without work, without possibilities, without any means of escape."

"In this context, some people continue to defend trickle-down theories which assume that economic growth, encouraged by a free market, will inevitably succeed in bringing about greater justice and inclusiveness in the world. This opinion, which has never been confirmed by the facts, expresses a crude and naive trust in the goodness of those wielding economic power and in the sacralized workings of the prevailing economic system. Meanwhile, the excluded are still waiting."

12.17 The Dalai Lama

In his excellent and highly readable book, *Ancient Wisdom, Modern World: Ethics for the New Millennium*, the Dalai Lama writes: "..At present and for the conceivable future, the UN is the only global institution capable of influencing and formulating policy on behalf of the international community. Of course, many people criticize it on the grounds that it is ineffective, and it is true that time and again we have seen its resolutions ignored, abandoned and forgotten. Nevertheless, in spite of its shortcomings, I for one continue to have the highest regard not only for the principles on which it was founded but also for the great deal that it has achieved since its inception in 1945. We need only ask ourselves whether or not it has helped to save lives by defusing potentially dangerous situations to see that it is more than the toothless bureaucracy some people say it is. We should also consider the great work of its subsidiary organizations, such as UNICEF, United Nations High Commission for Refugees, UNESCO and the World Health Organization..."

"I see the UN, developed to its full potential, as being the proper vehicle for carrying out the wishes of humanity as a whole. As yet it is not able to do this very effectively, but we are only just beginning to see the emergence of a global consciousness (which is made possible by the communications revolution). And in spite of tremendous difficulties, we have seen it in action in numerous parts of the world, even though at the moment there may be only one or two nations spearheading these initiatives. The fact that they are seeking the legitimacy conferred by a United Nations mandate suggests a felt need for justification through collective approbation. This, in turn, I believe to be indicative of a growing sense of a single, mutually dependent, human community."

12.18 Unfulfilled responsibilities of the mainstream media

Throughout history, art was commissioned by rulers to communicate, and exaggerate, their power, glory, absolute rightness etc, to the populace. The pyramids gave visual support to the power of the Pharaoh; portraits of rulers are a traditional form of propaganda supporting monarchies; and palaces were built as symbols of power. Modern powerholders are also aware of the importance of propaganda. Thus the media are a battleground where reformers struggle for attention, but are defeated with great regularity by the wealth and power of the establishment. This is a tragedy because today there is an urgent need to make public opinion aware of the serious problems facing civilization, and the steps that are needed to solve these problems. The mass media could potentially be a great force for public education, but in general their role is not only unhelpful - it is often negative. War and conflict are blatantly advertised by television and newspapers. Meanwhile the peace movement has almost no access to the mainstream media.

Today we are faced with the task of creating a new global ethic in which loyalty to family, religion and nation will be supplemented by a higher loyalty to humanity as a whole. In case of conflicts, loyalty to humanity as a whole must take precedence. In addition, our present culture of violence must be replaced by a culture of peace. To achieve these essential goals, we urgently need the cooperation of the mass media.

The predicament of humanity today has been called "a race between education and catastrophe": Human emotions have not changed much during the last 40,000 years, and human nature still contains an element of tribalism to which nationalistic politicians successfully appeal. The completely sovereign nation-state is still the basis of our global political system. The danger in this situation is due to the fact that modern science has given us incredibly destructive weapons. Because of these weapons, the tribal tendencies in human nature and the politically fragmented structure of our world have both become dangerous anachronisms.

After the tragedies of Hiroshima and Nagasaki, Albert Einstein said, "The unleashed power of the atom has changed everything except our way of thinking, and thus we drift towards unparalleled catastrophes." We have to learn to think in a new way. Will we learn this in time to prevent disaster? When we consider the almost miraculous power of our modern electronic media, we can be optimistic. Cannot our marvelous global communication network be used to change anachronistic ways of thought and anachronistic social and political institutions in time, so that the system will not self-destruct as science and technology revolutionize our world? If they were properly used, our instantaneous global communications could give us hope.

The success of our species is built on cultural evolution, the central element of which is cooperation. Thus human nature has two sides, tribal emotions are present, but they are balanced by the human genius for cooperation. The case of Scandinavia - once war-torn, now cooperative - shows that education is able to bring out either the kind and cooperative side of human nature, or the xenophobic and violent side. Which of these shall it be? It is up to our educational systems to decide, and the mass media are an extremely important part of education. Hence the great responsibility that is now in the hands of the media.

How do the media fulfill this life-or-death responsibility? Do they give us insight? No, they give us pop music. Do they give us an understanding of the sweep of evolution and history? No, they give us sport. Do they give us an understanding of need for strengthening the United Nations, and the ways that it could be strengthened? No, they give us sit-coms and soap operas. Do they give us unbiased news? No, they give us news that has been edited to conform with the interests of the military-industrial complex and other powerful lobbys. Do they present us with the need for a just system of international law that acts on individuals? On the whole, the subject is neglected. Do they tell of of the essentially genocidal nature of nuclear weapons, and the need for their complete abolition? No, they give us programs about gardening and making food.

A consumer who subscribes to the "package" of broadcasts sold by a cable company can often search through all 35 or 45 channels without finding a single program that offers insight into the various problems that are facing the world today. What the viewer finds instead is a mixture of pro-establishment propaganda and entertainment. Meanwhile the neglected global problems are becoming progressively more severe.

In general, the mass media behave as though their role is to prevent the peoples of the world from joining hands and working to change the world and to save it from thermonuclear and environmental catastrophes. The television viewer sits slumped in a chair, passive, isolated, disempowered and stupefied. The future of the world hangs in the balance, the fate of children and grandchildren hang in the balance, but the television viewer feels no impulse to work actively to change the world or to save it. The Roman emperors gave their people bread and circuses to numb them into political inactivity. The modern mass media seem to be playing a similar role.

12.19 The alternative media

Luckily, there are alternatives to the mainstream media, available primarily on the Internet, but also to a certain extent on radio and television and in films. One can think of such alternative media figures as Thom Hartmann, Leonardo DiCaprio, Amy Goodman and Oliver Stone, or Internet sites such as Common Dreams, EcoWatch, Truthout, Countercurrents, the Danish Peace Academy website and TMS Weekly Digest. Interestingly, Bob Dylan, a longtime counterculture hero, has recently been awarded the Nobel Prize in Literature.

12.20 Johan Galtung

One of the founders of Peace Studies and Conflict Resolution as academic disciplines, is Professor Johan Galtung (1930 -). He is the author of more than a thousand articles and over a hundred books in these fields. He was also the main founder of the Peace

Research Institute Oslo in 1959, and he served as its first director until 1970. Prof. Galtung established the *Journal of Peace Research* in 1964. A few years later. in 1969, he was appointed to the world's first chair in peace and conflict studies at the University of Oslo. Dr. Jan Øberg, a student of Prof. Galtung, went on to found the influential Transnational Foundation for Peace and Future Research in Lund, Sweden.

12.21 Universities Offering Peace Studies Degrees

Among the American universities and colleges offering degrees in Peace Studies and Conflict Resolution[8], one can mention the University of Notre Dame, the University of California, Berkeley, Georgetown University, Swarthmore College, Tufts University, Wellesley College. the University of North Carolina at Chapel Hill, Colgate University, Brandeis University, the University of Texas at Austin, George Washington University, DePauw University, Smith College, Syracuse University, Southern Methodist University, Saint Johns University, American University, Marquette University, College of Saint Benedict. University of San Diego, Creighton University, Willamette University, University of Denver, Duquesne University, John Caroll University, Earlham College, George Mason University, Juniata College, University of Utah and Manhattan College. A degree program in Peace Studies is also offered by Clark University[9].

In Costa Rica, the University for Peace (UPEACE)[10] offers a wide variety of courses. The departments of UPEACE include Environment and Development, International Law and Human Rights, and Peace and Conflict Studies. UPEACE also offers online education[11].

The many educational institutions founded by Soka Gakkai International offer courses in peace studies. Among these are Soka University Japan, the Toda Institute for Global Peace, and Soka University of America.

Masters courses in peace studies and conflict resolution[12] are also offered at Universitat Oberta de Catallunya, University of Malta, Durham University, Trinity College Dublin, Alice Salimon University of Applied Sciences Berlin, University of Nicosia, Australian National University, Middlebury Institute of International Studies at Monterey, Swansea University, Aarhus University, Utrecht University, University of Kent, CIFE, University of Technology Sidney, University of Bridgeport, Duquesne University, SOAS University of London, Chapman University, SIT Graduate Institute, Kings College London, Goethe University Frankfurt, Joan B. Kroc School of Peace Studies, Johns Hopkins University School of Advanced International Studies, University of Bradford Faculty of Social and International Studies, and University of East Anglia Faculty of Social Sciences.

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[8] http://colleges.startclass.com/d/o/Peace-Studies-and-Conflict-Resolution

[9] https://www2.clarku.edu/departments/peacestudies/gradprograms.cfm

[10] https://www.upeace.org/academic/academic-departments/peace-and-conflict-studies/peace-education

[11] http://www.elearning.upeace.org/

[12] http://www.masterstudies.com/Masters-Degree/Political-Science/Peace-and-Conflict-Studies/

12.22 Jakob von Uexküll and The World Future Council

Jakob von Uexküll belongs to a brilliant family. His grandfather was a famous Baltic-German physiologist who founded the discipline of Biosemiotics. Besides being a former Member of the European Parliament and a leader of the German Green Party, von Uexküll himself founded both the Right Livelihood Award (sometimes called the Alternative Nobel Prize) and also the World Future Council. [13]

A few outstanding voices

The greatest threats facing the world today are catastrophic climate change and thermonuclear war, but a large-scale global famine also has to be considered.

We give our children loving care, but it makes no sense do so and at the same time to neglect to do all that is within our power to ensure that they and their descendants will inherit an earth in which they can survive. We also have a responsibility to all the other living organisms with which we share the gift of life.

Inaction is not an option. We have to act with courage and dedication, even if the odds are against success, because the stakes are so high.

The mass media could mobilize us to action, but they have failed in their duty.

Our educational system could also wake us up and make us act, but it too has failed us. The battle to save the earth from human greed and folly has to be fought in the alternative media.

It is impossible to list all of the many thousands of brave, dedicated and eloquent people who write for the alternative media, or the equally brave and dedicated editors who publish these articles. But here are pictures of a few famous names that come to mind:

[13] http://www.rightlivelihood.org/
http://www.worldfuturecouncil.org/
http://www.worldfuturecouncil.org/gpact/

Figure 12.4: **The Norwegian mathematician and sociologist Johan Galtung (born 1930), pioneer of the discipline Conflict Resolution. He also founded the Peace Research Institute, Oslo and the Journal of Peace Research. He has published over 1000 articles and more than 100 books.**

Figure 12.5: **Jan Øberg (born 1951), co-founder and Director of the Transnational Foundation for Peace and Future Research, and editor of The Transnational. Born in Denmark, Dr. Øberg was formerly the leader of the Lund Peace Research Institute.**

Figure 12.6: **Mrs. Fumiko Galtung, Transcend Media Service Weekly Digest editor Antonio C.S. Rosa, and Johan Galtung in Norway, 2007.**

Figure 12.7: **Binu Mathew is the heroic and dedicated editor of the Internet journal "Countercurrents". He lives in the Kerala Provence of India, which has recently been hit by enormous floods, despite which he continues to publish his vitally important journal every day.**

Figure 12.8: **John Pilger (born in Australia in 1939). His outstanding documentary films on global problems have won a BAFTA award. He is a critic of American, British and Australian foreign policy, which he considers to be driven by an imperialist agenda.**

Figure 12.9: **The American film maker Oliver Stone (born 1946) has won three Academy Awards for his work, and he has been nominated for very many other Oscars. His Vietnam War trilogy "Platoon", "Born on the Fourth of July", and "Heaven and Earth" have won critical acclaim, as have his films "Salvador", "Wall Street", "Money Never Sleeps", "JFK", "Nixon", "W", and "Snowden".**

Figure 12.10: **Born in 1957. Amy Goodman co-founded Democracy Now: The War and Peace Report in 1996. She credits the great success of the program, broadcast on radio, television and the Internet, with the deficiencies of the mainstream media which leave a huge niche for alternative reporting. Amy Goodman has received dozens of awards for her work, including the Right Livelihood Award, sometimes called "The Alternative Nobel Prize", and the Gandhi Peace Award for making "a significant contribution to the promotion of an enduring international peace".**

Figure 12.11: **Thom Hartmann (born in 1951) is the host of the daily radio and television show "The Big Picture". As a writer, he has published more than twenty books. His book "Last Hours of Ancient Sunlight" inspired Leonardo DiCaprio's documentary "Before the Flood". Together with the DiCaprio family, Hartmann helped to produce an important short video "Last Hours", which is available at https://www.youtube.com/watch?v=2bRrg96UtMc . The video discusses the mass extinctions that can be observed in the geological record, and warns that anthropogenic climate change might cause an extinction comparable to the largest one, the Permian-Triassic event, by initiating a methane hydrate feedback loop.**

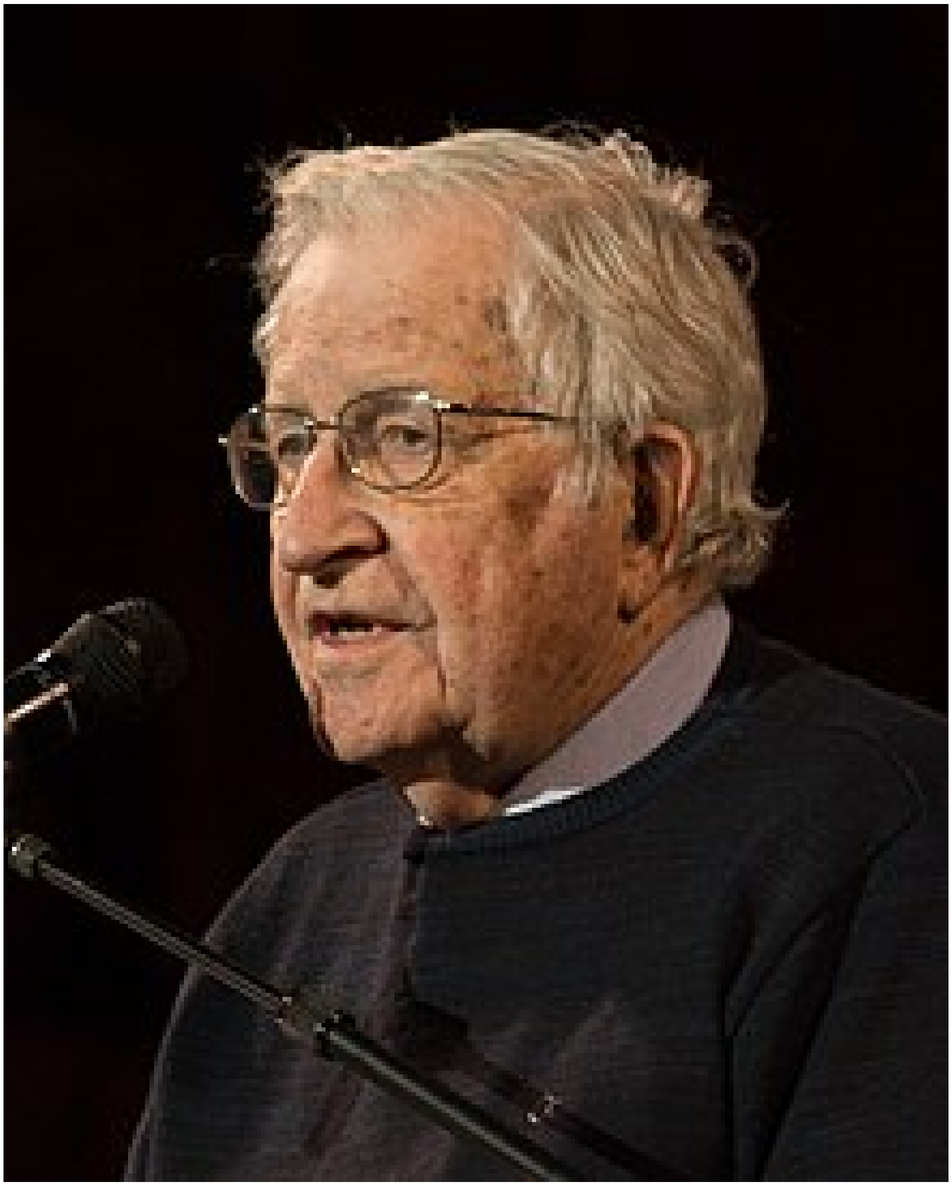

Figure 12.12: **Born in 1928, Institute Professor Emeritus Noam Chomsky of MIT and the University of Arizona is considered to be one of the greatest public intellectuals in the world. As a linguist and cognitive scientist, he revolutionized our ideas of the inherited universal grammar of humans. He is also a philosopher and historian, and has written more than 100 important books, many of which criticize the the mass media and US government policies. Professor Chomsky has stated that because of its climate change denial, the US Republican Party is the most dangerous organization in history, since its actions may lead to catastrophic climate change and perhaps the extinction of the human species.**

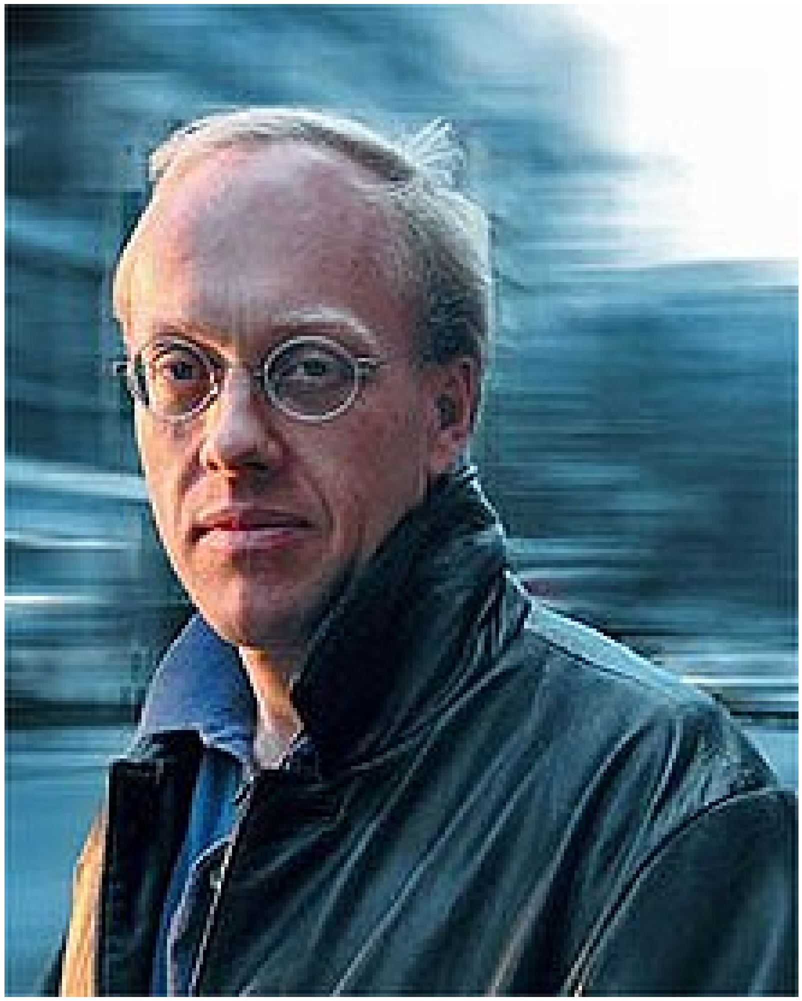

Figure 12.13: **Pulitzer Prize winning author Chris Hedges (born in 1956) worked for 15 years as a foreign correspondent for the New York Times, before resigning in 2005. He is the author of many important anti-war and anti-fascist books, including "War is a Force That Gives Us Meaning" (2002), "Empire of Illusion: The End of Literacy and the Triumph of Spectacle" (2009), "Death of the Liberal Class" (2010), "Days of Destruction, Days of Revolt" (2012), "Wages of Rebellion: The Moral Imperative of Revolt" (2015) and "America. The Farewell Tour" (2018). In a 2013 interview, Hedges said that "the left has been destroyed, especially the radical left, quite consciously in the whole name of anti-communism", and "we have allowed ourselves to embrace an ideology which, at its core, states that all governance is about maximizing corporate profit at the expense of the citizenry. For what do we have structures of government, for what do we have institutions of state, if not to hold up all the citizenry, and especially the most vulnerable?".**

Figure 12.14: **Award-winning author Naomi Klein was born in 1970 into a Canadian family of prominent peace activists. As a teenager, she felt embarrassed by her family's politics, and she reacted by becoming a mall-junkie, addicted to consumerism. Later, however, she became (in her own words) "less of a brat", and she wholeheartedly adopted her family's reformist traditions. Her first book, "No Logo: Taking Aim at the Brand Bullies" was published in 1999, shortly after the Seattle WTO protests, and it quickly became a highly-influential best-seller. Her famous book "The Shock Doctrine" (2007) argues that neoliberal politicians take advantage of disasters, when the public demands quick action, to ram through whatever changes they wish, and these are accepted uncritically by the change-demanding public, although they may have nothing to do with correcting the disaster. In another deservedly-famous book, "This Changes Everything" (2014), Naomi Klein addresses the twin threats of catastrophic climate change and thermonuclear war. She argues that environmental activists and peace activists ought to join hands and work together for system change. Partly as a result of her book, the slogan "System change not climate change!" was adopted by protest marchers both in New York and Paris.**

Figure 12.15: **The extremely distinguished scholar and author Professor Richard Falk was born in 1930, and is still very active today. He is the author of more than 20 books on international law and editor or co-editor of 20 others.**

The Eqbal Ahmed Centre For Public Education

This centre for public education (EACPE) can be reached on the link http://eacpe.org/ . It was established by the distinguished theoretical physicist Pervez Hoodbhoy and others, and it takes its name from the courageous writer, university professor and activist Eqbal Ahmed.

An article by S.M. Tatar in the Friday Times[14] states that "The late Eqbal Ahmad was an internationally known and respected Pakistani political scientist, intellectual, scholar and teacher who returned to Islamabad in the 1990's with a dream. He wanted to build Khaldunia University. Khaldunia could have been a game-changer in Pakistan's higher education system. Eqbal Ahmad taught at various US universities and was a key political voice in international affairs. He enjoyed the friendship and respect of the likes of Edward Said and Noam Chomsky - who admired his work, his independent thinking and his identification with the causes of oppressed peoples.

"Ahmad was an intellectual with roots in Pakistan, influencing thinking on major world events like the Vietnam war, Algeria's war of independence and the Palestinian tragedy. He was fully committed to his vision. He was not a desk scholar. He was part of the Algerian liberation movement in the 1960's and an active opponent of the Vietnam war. Along with others, he was charged with being part of a plot to kidnap Henry Kissinger, in an effort to end the Vietnam war. And he advised the the PLO leadership in Palestine!"

The Eqbal Ahmed Centre for Public Education states that "Knowledge translated into action is the most potent and powerful game-changer known to man. The wedding

[14] https://www.thefridaytimes.com/tft/a-dream-rudely-shattered/

of computers and telecommunications enables the transportation of ideas, the sharing of knowledge and the promotion of learning on a scale and with a speed that is near miraculous.

"The Eqbal Ahmad Centre for Public Education honours the life and work of Dr. Eqbal Ahmad, a Pakistani academic, social scientist, writer, public intellectual and activist. The Centre's web site of the same name is a rich mother lode of enlightening content for those who thirst for knowledge.They also keep adding to the content frequently, so the site is always worth a visit.

"We believe the site is a great resource for students as well. Some their content is directed at science students, particularly students of the physical sciences and mathematics. This particular section is rich in video content, and is certain to be helpful in acquiring a solid grounding in the subjects. Apart from such video lectures, there is also a great wealth of video material for those who wish to enhance their knowledge of scientific subjects in general."

Figure 12.16: **Professer Eqbal Ahmed (1933-1999).**

Figure 12.17: **Professer Pervez Hoodbhoy (born in 1950) is Zohra and Z.Z. Ahmad Distinguished Professor of Physics and Mathematics at Forman Christian College, Lahore. In 2013, he was made a member of the UN Secretary General's Advisory Board on Disarmament. Among the awards he has won are the IEEE Baker Award for Electronics (1968); the Abdus Salam Prize for Mathematics (1984); the UNESCO Kalinga Prize for the popularization of science (2003); the Joseph A. Burton Award (2010) from the American Physical Society and the Jean Meyer Award from Tufts University. In 2011, he was included in the list of 100 most influential global thinkers by Foreign Policy magazine. As the head of Mashal Books in Lahore, Prof. Hoodbhoy leads a major translation effort to produce books in Urdu that promote modern thought, human rights, and emancipation of women.**

The Danish Peace Academy

The Danish Peace Academy is an organization that was founded by Holger Terp. Holger completed his education as a librarian in 1992. In 1996, he participated in a course on "Internet and Presentation Technique" at the Academy of Fine Arts in Copenhagen. However, in 1999 he suffered a stroke, which made him blind in one eye and almost blind in the other. The stroke also affected Holger's speech, so that it was difficult to understand him when he talked. Instead of giving up, as many people would have done, Holger resolved to devote the remainder his life to the cause of world peace. Despite his severe handicap, he has achieved almost incredible results.

Holger's greatest achievement has been to found the Danish Peace Academy and to single-handedly create its enormous website. The website contains more than 90,000 files related to peace, in Danish, English and German, and it is currently visited by approximately 4,000 different people each day. Many of the visitors are from schools and universities in various parts of the world, who use the information on the website as a part of their studies.

In creating his website, Holger has used both his training as a librarian and the knowledge that he gained from the 1996 course at Copenhagen's Academy of Fine Arts. As a result, many parts of the website have great visual beauty because of the liberal use of images. For example, one can enjoy Holger's "Greenham Common Songbook", which is an account of the successful efforts of the woman's peace movement in England to prevent common land at Greenham from being used as a base for nuclear weapons. The songbook is a piece of history, illustrated not only by the songs, which the visitor to the website can hear performed by such artists as Peggy Seeger, but also by countless beautiful posters and photos from the era. Other special features of the website are numerous books, articles, poetry and song collections, a peace-related encyclopedia, and a timeline showing the history of the peace movement, from the middle ages up to the present.

Holger himself is the author or editor of numerous books, and he has translated Gandhi's autobiography into Danish. The example of Gandhi's life has always been a guide for Holger, and perhaps Holger's life can be a guide for our own efforts, as we strive to work for peace. If he could achieve so much with such a severe handicap, then the rest of us ought to be able to do something too.

Here are some quotations from the forward to Holger's autobiography. It is written in Danish, but I have made an approximate translation:

Militarism and the Military Industrial Complex have proved to be too big a mouthful for the peace movement, despite the fact that militarism has always been the main contributor to pollution and climate change. Ever since the First World War, military activities have been the largest users of fossil fuels.

Let's consider a nice little war somewhere. Besides the human and other biological costs, cities are ruined, as well as the country's administration and infrastructure. The gross national product collapses down to a tiny fraction of what it had been before the war. Military hardware is destroyed in war, and the environment is polluted with poisonous

Figure 12.18: **Holger Terp receives an award for his life-long efforts for world peace.**

byproducts of its degradation, such as heavy metals. This has always been the case with war. Furthermore, wars do not turn out as the politicians and war departments plan. Wars are unpredictable. Militarists make at least as many mistakes as the rest of us.

Therefore it cannot surprise even the most ignorant politician that war is primarily about resources and economy. The empty places in arsenals need to be refilled after a war. Governments buy from private weapons manufacturers, and a new war starts somewhere in a distant country whose policies have not given us unlimited access to cheap resources; and the mills of disaster begin to roll again, since weapon production is both resource-swallowing and environment-destroying. The more powerful weapons are, the more environmentally destructive they are, both when they are ,manufactured and when they are used....

It seems strange to me that religious fundamentalists can read in the Old Testament the commandment: "Thou shalt not kill". In other words, killing is both a sin and a crime; also when the killing is organized by governments. But soldiers do exactly the opposite of what religion requires. They go to war and kill. They do so because politicians are manipulated by the merchants of death. the arms manufacturers. One has to admire the war party's propaganda-machine. It is amazingly effective, with the result that the weapon industry's profits have grown enormously ever since the Iraq War of 2003. Soldiers and civilians are traumatized by war. Not so the politicians who start the wars, and certainly not the weapons manufacturers.


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