scientific knowledge, and new products and processes. For nations, it is a measure of the effort being put into science and technology.

A key point in Science, Technology and Society studies is that these activities are not isolated. They are all carried out in social, political and economic contexts. Therefore, if we are to understand what is happening in the modern world, we must understand how science influences the larger society. We must also understand how the larger society influences science.

In addition, there is another way in which the word *society* can be applied to science and technology. Scientists and technologists do not work in isolation. They work in universities, firms or research groups, and the functioning of these groupings is also a legitimate focus of study. Questions about ethics and conduct within these groupings, how they should be financed and how they are best organised, are also matters which researchers in Science, Technology and Society can ask about. You will notice this division in the book: Part One deals with matters pertaining to scientific and technological communities, the second part with relationships between science and technology and the wider society.

Describe

The origins of Science, Technology and Society studies

Any discipline has a history, involving founders and important scholars, and Science, Technology and Society is no exception. Although most work has been done since World War II, views of the relationships between science, technology and society go back for many centuries. Some of these are only incidental. For example, Plato, in the fourth century BC in the *Gorgias*, recognised the value of engineers, but went on to protest about their low status in ancient Greek society (Salomon 1973:6). Probably the first attempt to outline the ideal relationships between science, technology and society, though, was published in 1527 by the British lawyer and thinker Francis Bacon, in his book *The New Atlantis*. Bacon told of an imaginary voyage to a small island in the South Seas, where a civilisation was based upon science and technology. 'The end [i.e. goal] of our foundation is the knowledge of causes, and secret motions of things; and the enlarging of the bounds of human empire, to the effecting of all things possible' (quoted in Salomon 1973:7). In Bacon's imagination, scientists are accorded the same honours as royalty, and carry out their work in an organisation (called 'Solomon's House'), making scientific discoveries, and turning these discoveries into technology. This was a remarkable vision, long before science had demonstrated that it could influence technology in major ways (see Chapter 7 for more details). It is not surprising, therefore, that the vision had some important omissions. For example, Bacon did not provide any finance for his scientists and technologists. In modern terms, the R&D budget was zero!

It took many centuries for events to catch up with Bacon's vision. Thinkers in the Enlightenment, during the eighteenth century, laid out a program for extending knowledge and repelling superstition (Goodman and Russell 1991). Scientific academies were founded in Europe, many with the aim of promoting the useful advancement of knowledge (e.g. Merton 1968). During the French Revolution, the philosopher Condorcet advocated the realising of Bacon's vision on democratic lines (Salomon 1973:13). However, it was not until the present century, under the stimulus of war and political upheaval, that the discipline of Science, Technology and Society was launched.

How politics has played a crucial role in science and.....?

Politics has played a crucial part in the Science, Technology and Society movement. One of the earliest efforts arose out of the experience of the 1917 revolution in Russia and the establishment of a (supposedly) socialist state. Marx and Lenin argued that a socialist state like the Soviet Union represented a higher stage in social development than the liberal democracies of the West. One part of this theory was the materialist interpretation of history, which held that all significant social and intellectual change is caused by change in the productive forces of the economy. Of course, this places technology at the very heart of historical change.

This approach was also applied to science, and the Marxist view of science became known to scholars in the West through a conference on the history of science, called Science at the Crossroads, which was held in London in 1931. Notable among the Soviet delegation was a historian named Boris Hessen, who gave a paper entitled 'The Social and Economic Roots of Newton's *Principia*' (Hessen 1931). The *Principia* is Sir Isaac Newton's famous book, in which he put forward his three laws of motion, his law of gravity and much more. Hessen argued that Newton was led to address certain sorts of problems because their solution would lead to advances in technologies that were important to the dominant social forces of the time. These technologies included advances in navigation, mining, and the development of weaponry.

Although the Soviet Union collapsed in 1992, for a long time many Western thinkers were impressed by the communist experiment. In particular, it was noted that science and technology were an important part of communism: the state financed large scientific and technological projects and did not leave developments to chance.

Perhaps the most influential of these thinkers was the physical chemist J. D. Bernal, of London University. After visiting the Soviet Union in 1934, he concluded that science in Britain should be organised, like that in the Soviet Union, to solve pressing economic problems. He wrote a book called *The Social Function of Science*, which appeared in 1939. The key point of this book is that science is not primarily a search for the understanding of the universe; rather, it has a social function. This function is the improvement of the lot of humanity. Much of the book—naturally, with many references to the Soviet Union—is a plan for the direction and use of science in the national interest. There was a fierce reaction to this: many scientists felt strongly that science could not be directed, and in the United Kingdom after World War II (1939–45) the Society for Freedom in Science was formed to combat what they called 'Bernalism'.

How war has played a crucial role in science and.....?

War has also had a major impact on the analysis of the role of science and technology in society. Of particular importance was the development of the atomic bomb. As Chapter 3 recounts, the American Manhattan Project was set up in 1942, in conditions of complete secrecy, with the aim of making the first atomic bombs. Late in the war, the Japanese cities of Hiroshima and Nagasaki were destroyed by these bombs, forcing Japan to surrender. Many scientists who were engaged on the project later expressed regret at their involvement in the Manhattan Project. For the next fifty years, too, the rest of the world saw the production of huge numbers of nuclear weapons in the Cold War arms race between the United States and the Soviet Union, and lived with the prospect of total destruction.

Thus, at the end of World War II, Bernal's argument was clearly true, at least in its essentials. Governments knew that, for their countries to progress, they had to support scientific research and technological development. As a result of this, governments began to plan for science and technology.

Perhaps the most dramatic of these developments took place in the United States. A distinguished scientist, Vannevar Bush, was asked to report on a suitable plan for science after World War II. Bush recommended the setting up of a National Research Foundation—which later became the National Science Foundation. He also wrote a report, *Science, The Endless Frontier* (Bush 1945), which advocated the setting up of a national policy concerned with science.

The development of government science policy (as it came to be called) was mainly concerned with the use of limited funds for the best effect. After the war, spending on science was growing exponentially, with the money spent doubling roughly every fifteen years. This could not continue, as eventually science would consume all of the government's budget. Governments had to make choices about what to fund and what not to fund, and they had to develop criteria to help them make choices. They also needed to be able to measure the effectiveness of their decisions. This has restarted the debate about the freedom of science which first surfaced as a response to 'Bernalism'. Two key questions are whether governments or scientists are best equipped to decide what should be funded in science, and how 'success' is to be judged.

What do you understand by technology assessment?

More recently, Science, Technology and Society has come to embrace another area of study, known as technology assessment, and concerned with the impact of large-scale technologies on society. As technology becomes bigger and more complicated—with nuclear power stations, jumbo jets and supertankers—it follows that the impacts are felt far and wide if something goes wrong, even if it is only a minor problem. The nuclear disasters at Chernobyl (1986) and Three Mile Island (1979) are good examples. It is now clear that the likely impact of technologies should be assessed before they are introduced. Researchers in this field look at emerging technologies and try to ensure that positive outcomes are exploited and negative effects avoided. An extension of this is environmental impact assessment, which examines the effects of major developments on the physical environment.

From this brief discussion of how Science, Technology and Society arose, you will see that the discipline has emerged as a composite of a number of study areas. Some of these have been briefly discussed, and others, such as 'Ethics and Science' and 'Science and the Economy', are discussed elsewhere in this book. All the different approaches have some things in common: they are all concerned with science and technology in a social context, in which science and technology both shape, and are shaped by, the society in which they are performed. This basic approach is reflected throughout the book, and in the themes which arise from it.

Themes

This book is organised round two major themes. As you read each chapter, you should think about what has been said, and how it illustrates and extends the ideas implicit in the themes.

The first theme is this: *Science and technology are important in the world, and growing more so, and this presents both problems and opportunities to humanity.* The brief outline of Science, Technology and Society, above, shows how science has increased in importance. Chapter 6 on the Industrial Revolution discusses the importance of technology in this monumental event. The first part of Chapter 7 shows how science for the first time began to influence industrial technology. The discussion of science policy in Chapter 9 examines the ways in which governments have sought to use science.