UNIT 28  SCIENCE, TECHNOLOGY AND POLITICS

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28.1  INTRODUCTION

In the nation-building efforts, science and technology do play an important role. It has been said that the growing cleavage between the developed and the developing countries is no less factored on the evolution of scientific knowledge and dissemination of technology. No wonder, most countries of the developing world have initiated policies and strategies to develop indigenous science and technology in order to accelerate the process of development and at the same time distribute the benefits of new scientific know-how for the upliftment of the masses. Nevertheless, the appropriate policy package in respect of developing science and technology indigenously has been underlined by the political forces operational in any society. In other words, development of science and technology has increasingly become more a political decision than otherwise.

28.2  APPROACHES TO THE STUDY OF SCIENCE AND TECHNOLOGY

Philosophers and historians of science have differed in their approaches to the study of science and in the accounts they have given of its development. There is a divergence of opinion for example between what may be termed as “internalists” and “externalists”. The “internalist” school holds that science, both in its content and trajectory of growth, is independent of social and political forces. For those who consider science as nothing less than “truth institutionalised”, the community of scientists is something very special and worthy of emulation. Unlike most human communities, the community of scientists is often seen by them as democratic, disinterested, tolerant and above all, rational. Although there are many variations of such a view, this position has been supported in large measure by such scientists-philosophers as Jacob Bronowski, Michael Polanyi, Anatol Rapaport, and Jacques Monod.

Many modern accounts of the development of science, however, are “externalists” to a greater or lesser extent and reflect the belief that social and political factors play an
important role in the development of both science and technology. This view emphasises science as a social activity which is conditioned by the socio-political and economic context in which it develops. Among those subscribing to such a view of science are John Bernal, Thomas Kuhn, George Basalla, and Paul Feyerabend.

28.3 OBJECTIVES OF MODERN SCIENCE AND TECHNOLOGY

Examining the nature and purpose of scientific and technological activity, it may be noticed that this activity has twin objectives. Firstly, through the acquisition of scientific knowledge it continuously widens the horizon of man and enlightens his outlook. Growth of science has led to the shrinking of the area of darkness. Phenomena which held man in awe and fear are now understood, controlled and taken advantage of. Afflictions of man which were considered as divine punishment are now understood in terms of their natural causes and cured.

The other role is to develop, through the creation of new artefacts, materials and goods to meet human requirements, basic necessities as well as improving the quality of life. The former include those which are not found in nature, but are exclusively man made. The growth of both dimensions together help to create a balanced society. The two dimensions were beautifully expressed in the early stages of the development of science and technology in Europe.

Science and technology began in Europe as a revolt against the medieval intellectual outlook and technology as a new mode of production. It was only through the social and political struggle lasting over two to three centuries that they were able to establish science as a major intellectual and social activity. The battles which were fought were many, in which many paid a heavy price. This is evident from the movement of Encyclopaedists in France, of natural philosophers like Haeckel in Germany, and that of Thomas Huxley in England. In Russia, and later in China this role was institutionalised through the communist cadre.

The machine production system was also not able to establish itself without resistance, and there were many attacks on it besides the Luddites. Further, with regard to the organisation of the production system, there were many experiments, starting from Robert Owen and others, with diverse motives and objectives, before the production system was consolidated in its present form.

Both science and technology created and nurtured a production system which brought about a change in human outlook, by widening horizon and bringing him out of the rut of medieval outlook and philosophies on the one hand and provided new resources and materials, and ushered liberty, equality and prosperity.

28.4 NATIONALISATION OF SCIENCE AND TECHNOLOGY

The period between the First and Second World Wars was significant in terms of politicisation of science and technology. National governments in Britain, France and
Germany, came forward to provide policy direction and funding to scientific and technological development in these countries. This trend towards ‘Nationalisation’ of science was a marked departure from earlier practice of scientific enterprise maintaining a safe distance from the political sphere. Throughout the 18th and 19th centuries scientists had carried out research and development in their own independent laboratories without any political control.

The Second World War and the Cold War gave a fresh impetus to scientific and technological development under the auspices of national governments. The Manhattan Project organised by the US government for the development of nuclear energy, including the nuclear bomb, indicated the direction that science and technology were to take during the second half of the twentieth century. The US lead in this respect was soon followed by other great powers like the USSR, France, UK, and China.

Among the developing countries, India and Brazil took steps to frame science policies to give direction to scientific and technological development. Unlike the great powers, the governments in developing countries sought to use science and technology primarily for social and economic development. Agriculture, health, and heavy industry, were the main areas in which the government provided funding and organisation for research and development.

However, the developing countries were not averse to providing funding and support for research projects aimed at increasing their power and prestige. Countries like India and Brazil, for instance, started supporting research in the fields of nuclear energy and aerospace soon after the Second World War. In fact the best of scientists and engineers in these countries could be seen to be working in the key areas of nuclear and space research.

The difference in financial and educational resources available to the governments in developed and developing countries was so vast that the gap in their respective scientific and technological development could not be bridged. Over the decades, the pace of scientific and technological development in the developed countries has been much faster than that in the developing countries. Only a few developing countries, like China, India and Brazil have been able to harness science and technology successfully for building their economic and industrial capabilities.

As the beginning of the 21st century, the developed countries occupy a position of dominance in the support and conduct of research and development (R&D). More than 90 per cent of all R&D in science and technology in the present day world is conducted in the developed countries. Within the developed countries, U.S. R&D expenditures equal the combined total expenditures of Japan, the United Kingdom, Canada, France, Germany, and Italy.

Governments continue to pursue broad national and regional efforts to capture the benefits of science and technology. In addition to emphasising market forces and liberalisation of investment, their strategies have included strong investments in education and training. In the latter part of the 1990s, these developments reflected a growing conviction that some kind of new economic reality was coming into existence; a
“knowledge-based” economy, marked by the systematic generation, distribution, and use of research knowledge for economic gain. This notion, emanating from the United States and Japan, seemed to be underscored by the positive US economic performance in the latter half of the 1990s.

Government and industry efforts in several nations may foreshadow the eventual creation of new centres of scientific, technological, and engineering excellence. China and India are fast emerging as new technological powers with strong capabilities in most areas of science and technology. The resulting international knowledge flows may benefit all nations but will also pose challenges to those seeking to exploit these flows effectively.

In recent decades nations have pursued technological strategies to gain strength in high-technology areas like space, communications, and bio-technology. High-technology industries are important to national economies because they produce a large share of innovations, including new products, processes, and services that help gain market share, create entirely new markets, or lead to more productive use of resources.

High-technology industries are also associated with high value-added production, success in foreign markets, and high compensation levels. Results of their activities diffuse to other economic sectors, leading to increased productivity and business expansion. The international competitiveness of their products and processes thus provides a useful market-based measure of the performance of a nation’s science and technology (S&T) system.

Many decades of support for basic research provide the basis for past and current innovations that generate economic benefits. During the 1990s, the United States maintained and improved its position in the exploitation of new knowledge, techniques, and technologies for economic advantage. By the end of the century, the United States remained the leading producer of high-technology products, providing more than one-third of the world’s output. US-based pharmaceuticals, computer, and communications equipment industries gained in world market share over the decade; only the aerospace industry lost market share.

The world’s total manufacturing output has been rising during the past two decades, and the share of high-technology industry products in that output has increased. Worldwide, high-technology manufacturing rose from 7.6 per cent of total manufacturing output in 1980 to 12.7 per cent by 1998. The high-technology share of U.S. manufacturing output increased from 9.6 to 16.6 per cent during the period, and the United Kingdom experienced similar growth. The high-technology output shares of other European Union members also increased but stayed at lower levels: 11.0 per cent for France and 9.0 per cent for Germany. In Asia, the high-technology sectors in the Taiwanese and South Korean economies grew especially rapidly, to 25.6 and 15.0 per cent, respectively, of their 1998 manufacturing output.

Heightened international attention to the economic advantages bestowed by the exploitation of new knowledge, processes, and products has led to increases in R&D spending around the world. This broad international expansion is reflected in a gradual decline of the U.S. share of total R&D performed by member countries of the Organisation
for Economic Co-operation and Development (OECD). Nevertheless, at 44 per cent of the estimated $518 billion 1998 OECD total, the United States remained by far the largest single performer of R&D. Its R&D expenditures equalled the combined total for Canada, France, Germany, United Kingdom, Italy, and Japan. By itself, Japan accounted for 20 per cent, and the European Union accounted for 30 per cent of the OECD total.

The decline in the share of government funds for R&D is a key trend common to all major industrial nations and many other OECD countries. In the mid-1980s, these nations derived an average of 45 per cent of their R&D funds from government sources; by 1998, this figure had fallen to less than one-third. The relative retrenchment reflects the broad growth of private sector industrial R&D, reductions in defense R&D in some key nations, and broader economic and spending constraints on governments.

### 28.5 GLOBALISATION OF SCIENCE AND TECHNOLOGY

The expansion of national R&D efforts in many countries is taking place against the backdrop of growing international collaboration in the conduct of R&D. The end of divisive Cold War, expansion of convenient and inexpensive air travel, and advent of the Internet have facilitated scientific communication, contact, and collaboration. More R&D collaborations can be expected to develop with Internet-facilitated innovations such as virtual research laboratories and the simultaneous use of distributed virtual data banks by investigators around the globe.

Indications of this growing international activity can be drawn from the behaviour of researchers, firms, and inventors. A rising share of the world’s scientific and technical publications has co-authors who are located in different countries. U.S. investigators play a major part in these collaborations, and their co-authorship ties extend to a wider range of countries than those of scientists and engineers in any other nation. Regional research collaborations are also growing stronger among European and Asian countries.

Greater global collaboration is not limited to the conduct of scientific research. In many countries, foreign sources of R&D funds have been increasing, underlining the growing internationalisation of industry R&D efforts. In Canada and the United Kingdom, foreign funding has reached nearly 20 per cent of total industrial R&D; it stands at nearly 10 per cent for France, Italy, and the European Union as a whole. Foreign R&D funding remains low in Germany, however, and it is negligible in Japan.

The United States is attractive to foreign firms because of its technological sophistication and size of the market. R&D spending in the United States by foreign affiliates rose to a record $22 billion or 15 per cent of company-funded R&D in 1998. U.S. affiliates of European companies (including Daimler-Chrysler) accounted for 72 per cent of this total, the Asian/Pacific region for 14 per cent (four-fifths Japan), and Canada for 11 per cent. Foreign-owned subsidiaries of firms in particular countries tend to be concentrated in particular industries (e.g., computer and electronic products for Japan). Also in 1998, 715 R&D facilities were operated in the United States by 375 foreign-owned firms. Japan owned 35 per cent of them; Germany and the United Kingdom each owned 14 per cent.
US firms are also investing in R&D conducted in other locations. R&D spending by US companies abroad reached $17 billion in 1999, rising by 28 per cent over a brief three-year span. More than half this spending was in the areas of transportation equipment, chemicals (including pharmaceuticals), and computer and electronics products. Both inflows and outflows of foreign funds are dominated by manufacturing sector R&D. Relatively low levels of service sector R&D spending suggest a greater difficulty in exploiting non-domestic locations.

Globalisation is also indicated by the strong growth of international patent families, which are patents filed in multiple countries covering the same invention. Their number has grown from 249 in 1990 to 1,379 in 1998. This development indicates the globalisation of both markets and intellectual property. It also suggests increasing access to knowledge and know-how flows on a global scale.

28.6 SCIENCE AND TECHNOLOGY IN INDIA

Science & Technology (S&T) has always been an integral part of the Indian culture. Natural Philosophy as it was termed in those ancient times was pursued vigorously at institutions of higher learning. The contributions made by the scholar-scientists Aryabhatta, Bhaskara, Brahmagupta, Dhanvantari and Nagarjuna, to name a few, to the fields of mathematics, astronomy, medicine and chemistry during the prehistoric period are legendary and invaluable not only to Indian S&T but also to the knowledge base of the humanity at large.

The astronomical observations at Jaipur and New Delhi and the Ashoka Pillar in New Delhi stand as living testimonies to the high standards of Indian capabilities. The dawn of the present century witnessed great strides made by Indian scientists like Srinivasa Ramanujan, J.C. Bose, P.C. Ray, Meghnad Saha, C.V. Raman, S.N. Bose, Birbal Sahni, P.C. Mahalanobis and M. Visvesvarayya, who have left indelible imprints on the world S&T scene.

The innate ability to perform creatively in science came to be backed with an institutional set-up and strong state and political support after country’s independence in 1947. Since then the Government of India has spared no effort to establish a modern S&T organisation in the country. India’s first Prime Minister Pandit Jawaharlal Nehru gave whole-hearted support to a concerted programme for the promotion of S&T in the country. As a result, many new S&T departments and laboratories were set up and the pursuance of scientific research started in an organised manner.

Jawaharlal Nehru firmly believed that Science and Technology can be the twin tools that would help bring about social equity and economic development to enable India join the mainstream of the world community. This conviction was reflected in the Scientific Policy Resolution (SPR) of 1958, the aim of which was “to foster, promote and sustain the cultivation of sciences and scientific research in the country and to secure for the people all the benefits that can accrue from the acquisition and application of scientific knowledge”.

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28.6.1 Achievements for India

The commitment of Indian Government to promote socio-economic growth of the country through the use of S&T has shown remarkable successes in a short span of five decades.

India today ranks as one of the few developing countries, which have achieved self-sufficiency in food production. The country has endeavoured to fulfill the basic needs of healthcare and housing for a large section of its people.

In the field of basic research, the country has done notably well and has established major research groups with world-class capabilities in various emerging and frontline areas of Science & Technology. Some examples are the areas of Molecular Biophysics, Molecular Biology, Neuro-biology, Liquid Crystals, Biomedical Devices, Superconductivity, Condensed Matter Physics, Astronomy and Astrophysics, Powder Processing and Advanced Materials, Organic Chemistry, Solid State and Surface Chemistry, Numerical Weather Prediction, Parallel Processing and Atmospheric Sciences.

India occupies a unique position in the world having formulated its own nuclear programme and cultivated self-reliance in areas of reactor technology and its entire associated fuel cycle. The country designs, constructs and operates nuclear reactors, fabricates the require fuel—reprocesses it, and treats the waste generated in the entire fuel cycle in a comprehensive manner by a totally indigenous effort.

Similarly, in the high-tech area of space research India can now design, build and operate state-of-the-art communication and remote sensing satellites as well as launch 1000 kg class remote sensing satellites into polar sunsynchronous orbit. Many of the technologies developed for the nuclear and space research programmes are now finding their way into the market and being used in other sectors. Indian industry is striving to keep pace with these developments.

Yet another achievement which speaks of high level of S&T capability of India is the development of supercomputers—only a few advanced countries have this capability today.

In the field of Aeronautics, the country has developed and successfully flown an all-composite trainer aircraft. Projects are in hand for the development of Light Transport Aircraft and Light Combat Aircraft.

A large number of technologies have been developed and commercialised for various chemicals, including petrochemicals and agrochemicals; industrial catalysts; drugs and pharmaceuticals; biomedical devices; food processing; leather processing and products; engineering materials and equipment; electronic equipment and construction materials, to cite a few. Many of these technologies have also been marketed abroad, an indication of their global competitiveness.

Special mention may be made of the technologies developed for industrial catalysts, such as Encilites, for producing important petrochemicals like p-xylene, ethylbenzene and olefins, and for drugs such as AZT (anti-AIDS), Etoposide (anti-cancer) and Centchroman (non-steroidal oral contraceptive).
Micropropagation of several trees and crops by the plant tissue culture technique, development of ELISA and PCR techniques and DNA probes for detecting enteric pathogens in drinking water, development of toxigenic oral vaccine for cholera and conversion of molasses to ethanol using a special yeast strain are a few examples of achievements made in the field of Biotechnology.

The major programmes being pursued in the field of marine sciences include exploration and exploitation of living and non-living marine resources, study of air-sea interactions, coastal zone management and scientific expeditions to Antarctica. India has established its reputation for carrying out oceanographic surveys. A major assignment completed was the comprehensive survey of the Caribbean waters under the CORE project.

India’s success in exploration and survey of deep sea polymetallic nodules has earned it the distinction of being registered as a Pioneer Investor under the UN Convention on the Law of the Sea which has recently come into force. An area of 150,000 sq. kms has been allotted in the Central Indian Ocean to India for survey, exploration, and ultimate retention of 75,000 sq. kms. of high abundance area.

28.6.2 Drawbacks for Developments in India

Inspite of these significant achievements, a very large section of Indian society has not benefited much from the advances in science and technology in and the world. The main reason for this is that in contrast to European developments, the introduction of science and technology in India had little or no developmental background. It was introduced as an instrument of British colonialism, in the form of foreign products sold in the country. Major changes were introduced in the native economy to meet the demands of raw material procurement and marketing of products which adversely affected the people.

Later, when limited industrialisation was introduced in India, it was created around imported technology so that the dependence on British heavy industry continued. This created a dual production system, and the two systems came to be known as “Indian” and “foreign”. The former got associated with nationalism. Under the impact of national movement, and Gandhian ideas, it got incorporated as one of the possible alternative systems of production. It tried to avoid the excessively centralised, dehumanised and exploitative character of organised industry. This duality continues to this day in scientific, technological, and industrial planning of the country, with philosophic, national, social and cultural overtones.

The reason for the lack of success of indigenous science and technology lay in the nature of the infrastructure built for science and technology, i.e., the education system and the technical system. The institutional structure was shaped to meet the requirements of the industrial units built around imported technology. It did not interact, and was not meant to, with existing small scale industrial infrastructure in the country. In addition, science education and technical research system was not a result of natural growth, but was imposed from above and was created in the image of the institutions abroad. The science and technology system was thus socially and culturally isolated from the grassroots of Indian society and economy from the beginning.
This was in sharp contrast to the experience of Europe, and later Japan, where the emerging science and technology continuously interacted with the cottage and small scale industries, with the objective of better utilisation of raw materials, improving and up-scaling the production system and improving the quality of products. The institutional structure of education, technical expertise and research and development in these countries was shaped to meet the requirements of industry and also to continuously interact with it.

Being dependent on government support, science and technology in India became extremely bureaucratised and could not play the role of bringing about social transformation. Most significant choices of alternatives in science and technology were made through the medium of what C.P. Snow has termed as “closed politics”. The term refers to “any kind of politics in which there is no appeal to a larger assembly in the sense of a group of opinions or an electorate, or on an even bigger scale what we call loosely ‘social forces’.”

Science as an academic discipline was introduced in India much later than foreign technology. It was not part of an intellectual and social revolt, against the then prevailing outlook and attitudes, nor did it become an instrument of fight against superstitions and obscurantism. Consequently, its concepts and ideas could not become a basis for generating a new outlook and value system. Being associated with foreign rule and education, its ideas and outlook were not understood by a large number of people. In other words, the manner and the language of introduction of science and technology in India came effectively in the way of the proper appreciation of the role of science as an intellectual effort and the dissemination of scientific knowledge, ideas and values amongst the people.

In addition, this limitation of science also isolated the scientists from the people, their problems, social attitudes and general ethos. Scientists came to be concerned in such a situation, increasingly with esoteric professional work, research projects, and scientific investigations. Much of the activity of the scientists was connected with institution building, rather than evolving a wider role for science and technology in the society.

Consequently, the growth of science and technology in India has been partial and superficial. The scientific temper in society, which Nehru tried to develop, is yet to take roots. The vast majority of people, not being exposed to science and technology, are unable to understand its implications or benefit from the gains of development. They still look towards traditional ideas and beliefs for guidance, and solution of their problems. Having grown up in age old traditions, cultural ethos and outlook, their hold on traditional beliefs becomes stronger when they feel insecure and threatened. This explains the growth of irrationalism and obscurantism even as India has moved into the 21st Century.

### 28.6.3 The Outlook for Future

After analysing the interaction of science technology and politics in India and the world over more than half century, it is clear that as we progress into the new millennium, the outlook is bright. The Indian industry—for example, the pharmaceutical industry—is developing fast and it is good to see their recognition of the importance of not only
applied research but also basic research. The hold of bureaucracy over the scientific establishment is also decreasing, and the government is keen to encourage private sector participation in scientific and technological development. There is also an emergence of a large number of non-governmental organisations concerned with science and technology which are committed to protecting and promoting the interests of the people. These trends indicate a bright future for the growth of science and technology in India.

28.7 SUMMARY

Science and technology has been variously viewed as democratic and rational or a social activity conditioned by the socio-political and economic context in which it develops. Its objectives are to enlighten mankind and to meet human requirements and necessities improving the quality of life. In the period between the First and Second World War, British, French and German governments came forward to give policy direction to scientific and technological development leading to the nationalisation of science and technology. The pace of scientific and technological development in developed countries is much faster than that in developing countries. Technological innovations have been made in age, health, heavy industries, nuclear and space research, communications and bio-technology. The international competitiveness of a nation’s products provides a useful market-based measure of the performance of its science and technology system. The economic advantage of new knowledge and processes has led to increased research and development (R&D) spending around the world. There is also growing international collaboration in the conduct of R&D with the end of Cold War and expansion of inexpensive air travel and internet. R & D spending in a country by foreign and private affiliates is also increasing. India has done well in basic research, establishing major research groups with world class capabilities but its relative lack of success lies in its infrastructure built for science and technology and its lack of interaction with the existing small-scale industrial infrastructure in the country. The institutional structure of education and R & D was not suitably shaped to meet the requirements of the country. But with the hold of bureaucracy decreasing and the private sector participation in scientific development, the outlook seems to be bright.

28.8 EXERCISES

1) How has the study of science been approached by philosophers of science? What are the objectives of science and technology?

2) What led to nationalisation of science and technology? How has its development varied in developed and developing countries?

3) What accounts for globalisation of science and technology?

4) What are India’s achievements and drawbacks in the development of science and technology?