Transfer of science and technology as well as exchange of science and technology among nations has become a very important part of international relations, particularly since the Second World War. Historically, Government interest in technology was connected mostly with collecting taxes and making the tools and techniques of war. Technology diffused freely across the boundaries of nations in the past because the sovereignty of nations could not be extended to prevent such movements. The states did not have the necessary apparatus or intelligence to restrict or retard such movements of technology. Gunpowder and guns diffused throughout the world, as did silk, tea, indigo, and jute technologies. As the world contracted and technology speeded up, antisepsis, discovered by Joseph Lister and used effectively in the Crimean War, and the steam engine invented by James Watt were very quickly employed by other countries both in war and in peace by the end of the nineteenth century.

The penetration of technology into national and Governmental affairs has been quite rapid since the First World War; it has been phenomenal since the Second. The metal industries of steel, copper, and aluminium and the electrical industries of making motors, generators, switches, and electric lamps diffused throughout Europe and parts of Asia—marginally even to some of the developing nations. The war technologies of making explosives, guns, and other equipment also percolated throughout the developed nations. Industrial technologies of shipbuilding (including battleships), gasoline and petrochemicals, tanks and automobiles did not diffuse as quickly or as widely. Nevertheless there was a perceptible pressure by the developed nations in these directions. The Second World War speeded up technological development enormously. Mass production methods were applied by the United States to the manufacture of aircraft and shipbuilding. The Germans developed enormous productivity in the manufacture of guns, tanks, and aircraft. Moreover, communication equipment and techniques were developed by Germany, the United Kingdom, and the United States. The war ended in a burst of

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technological innovation in Germany and the United States. The \( V_1, V_2 \), and the atom bomb became symbols of the Second World War. These developments made the penetration of technology into international diplomatic affairs almost inevitable.

This was perhaps most clearly realized immediately after the Second World War in the United States and in more or less degree by several other nations. A scientist and Government official named Keith Glennan wrote a report at the instance of President Harry S. Truman in 1950 on technology and foreign affairs. This document was secret for a while, but after Dwight D. Eisenhower became President in 1952, it was released as a public document. Glennan made the point in his report that science and technology were increasingly important factors not only in the internal affairs of a nation but also in the conduct of international relations. He sought to warn the US Government that the conduct of foreign affairs in the United States could not be pursued without a deep awareness of the implications of technology in the conduct of its foreign relations. Some of the things that Glennan spelled out clearly nearly thirty years ago are applicable to almost every nation today. He articulated clearly that a Foreign Ministry or State Department needed to be aware of the state of technology in the world and the technological strength and weaknesses of its own society. He wanted Foreign Service officers of the United States to be “technologically literate”. The US Government implemented Glennan’s recommendations and set up an internal planning section within the State Department which would devote itself to the requirements of US foreign policy with regard to science and technology. Apart from the internal planning cell within the State Department that would keep in touch with scientific institutions within the country, it appointed Science Attaches in all its major embassies round the world. It is important to note that by the fifties the United States had posted a distinguished professor of the California Institute of Technology as its first Science Counsellor to New Delhi; our own Government was able to reciprocate only some twenty years later. However, US perceptions and actions were by no means unique. The Soviet Union and the United Kingdom also, either at the same time or soon thereafter, became increasingly aware of the technological dimensions of their respective foreign relations. The Soviet Union not only set up bureaus within their State Committee for Foreign Affairs but also established linkages with the USSR Academy of Sciences to be able to make technological and scientific assessments and plan for scientific technological and technical exchanges with “friendly nations”. Prime Minister Clement R. Attlee of the United Kingdom was aware of his Government’s own needs as well as US thinking in the matter. The British had their own wartime experience which motivated them strongly to incorporate technological understanding in the working
of their Foreign Office. Unfortunately the British Foreign Office only paid lip-service to these new ideas. Attlee, thanks to the influence of people like Blackett, tried to encourage ideas of the technological dimension in the Foreign Office, but the British Foreign Office was quite tardy about changing their structures and operations to fit in with these new ideas. However, in course of time, the United States, the Soviet Union, and the United Kingdom—in that order—did appoint Science Attaches or Minister Counsellors to look after matters relating to science and technology in their major embassies/High Commissions over the years.

The rapid development of nuclear weapons, the problems of nuclear power, and the difficulties of nuclear proliferation have been matters of international discussion ever since the Second World War. The Foreign Ministries of many nations were interested in participating in the debate, but in order for them to deal with these matters effectively there was need of scientific and technological expertise of a high order. In countries like France, the Soviet Union, the United States, the United Kingdom, and so on, the Governments were able to make adjustments to the new situation by incorporating science planning cells or scientific evaluation cells in their Foreign Ministries. In our country, the interests of Jawaharlal Nehru and Homi J. Bhabha in nuclear energy and power led to the Department of Atomic Energy having a small cell of its own to deal with foreign relations with regard to nuclear matters. While this strengthened the Government of India's ability to participate in the nuclear debate in the United Nations, the International Atomic Energy Agency (IAEA), and other international forums, it also in some ways fractionated the totality of foreign relations in technological matters and delayed the development of foreign policies over the entire range of science and technology. It also created a certain amount of resentment as between the other Departments of Government dealing with science and the Department of Atomic Energy. The anxiety and suspicions of the Ministry of External Affairs extended not only to the Department of Atomic Energy but to the other Departments concerned with science; for that Ministry looked upon atomic energy as a successful interloper, and it looked upon others as intending interlopers. When additional problems came up, which had substantial scientific and technological components such as the development of aircraft industries, ballistic missiles, and satellites, problems of ocean resources and the petroleum technologies, our External Affairs Ministry sometimes found itself occupying a back seat because of its lack of internal expertise coupled with the absence of close understanding of the Indian and world technological scene which could only derive from close association of scientists. When, in 1962, after the debacle on the Sino-Indian borders, we asked for technology
for aircraft industry, the only taker was the Soviet Union for political reasons of its own. Sufficient technological backup expertise would have made such an agreement far more fruitful.

Perhaps it is unreal to expect politicians or Foreign Office bureaucrats to seize opportunities in bilateral discussions or international debates or to understand the technological and economic implications of exchanges with real effectiveness without a fair measure of scientific understanding. The result is that in India, as in most developing nations, political discussions tend to centre on rather fixed positions derived from prepared briefs, or ideological positions, or both. Our politicians and bureaucrats are often unable to seize opportunities indicated in views and arguments to open up new options as and when they become available.

Energy, special metals, and resources of metalliferous ores, transnational environmental pollution, ocean-bed resources, etc. have now become international issues. The large scientific and technological components of these issues have to be borne in mind. Without sufficient technological backup it is often possible for a bureaucrat to convince himself that the arguments presented by his own country's claims are not as justified as the claims made by the developed nations and so accepts disadvantageous positions. That is why technological literacy is so important. What is not often understood by political leaders and bureaucrats is that scientists and technologists serve better as partners than when they are treated as if they were on tap.

The activities of multinational corporations (MNCs) represent another dimension of international transfer of technology. The MNCs have set up industries in the various developing countries, and many of them have been able to obtain terms which are not equitable or justified owing to lack of technological understanding on the part of the bureaucrats and political leaders responsible for the issue of licences etc. This kind of thing creates subsequently a feeling in the latter that they have been imposed upon by the MNCs. It also gives rise to a certain amount of distrust and unhappiness both in the recipient nation and in the nation of origin of an MNC. It can in some cases even lead to closure of an MNC in a developing nation to the unhappiness of both the Governments concerned. There are instances of such occurrences both in our country and elsewhere. Many of these problems arise because of lack of technological evaluation and failure to set down clear terms that would safeguard the interests of both the Governments and people concerned and the MNCs.

This problem has taken a new turn for us since we began to export technology to South-East Asia and to Arab and African lands, for some of our own corporations there tend to behave somewhat like the way the MNCs have behaved with us. Our bureaucrats and politicians are not
always as cautious or careful as they should be mainly because their lack of technological understanding makes it easy for them to accept the arguments of our entrepreneurs when they invest abroad.

In foreign trade likewise there are a large number of non-tariff barriers which often act to the disadvantage of the developing nations. These barriers may be in the form of packaging standards, quotas, environmental standards, and so on. The arguments made against them by a less developed country (LDC) are often countered by various other arguments, both technological and economic, which the bureaucrat is often unable to meet. Access to special materials such as chromium, molybdenum, tin, nickel, uranium, and copper has also prompted some developed nations to use double standards in their economic and technological dealings with the developing countries. One glaring example is that of South Africa. Others are Angola, Namibia, and Zaire.

Several kinds of scientific and technological problems arise between two nations when they are obliged to share resources such as water-flows or when they are called upon to address themselves jointly to questions such as water management and pollution in contiguous areas (such as the areas of the Ganges system in Bangladesh and India or the Danube and Rhine basins in Europe).

The unrestricted process of acceleration of technological development creates numerous problems of dependency, access to raw materials, markets, and political influence—all or some of these combined in various ways. The wide range of these instances provides a strong basis for arguments in favour of promoting understanding of the technological content of relations between nations in modern times. There are also often not very obvious technological or scientific aspects of international relations which can be discovered only through close analysis: The selling of a sophisticated computer by the United States to the Soviet Union becomes a matter of diplomatic exchange; as does the linking of the two spacecraft Soyuz and Apollo. Such decisions are not just scientific; nor are they merely political. We have examples in our country of multiple import of the same technology by different companies leading to higher costs and foreign-exchange drain. In Japan this is effectively prevented by the Ministry of Industries (MITI). MITI examines every proposal for import of technology, and it can compel a Japanese company to buy technology from it rather than from a foreign company and thus prevent any exclusive use of a technology obtained from abroad. Japan has been able to develop the electronic industry by effective use of such technology ownership clauses and internal competition and buy-back clauses in their agreements with the United States as would enable it to sell back in the United States both electronic goods and electronic knowhow.

The few instances mentioned above indicate that modern diplomacy,
trade, and foreign relations have a large technological and scientific component. We may call this technological diplomacy. The example of space diplomacy in the Soyuz-Apollo experiment cited above shows how the political leaders of the two countries were able to overrule their mutual suspicions of their respective military bureaucracies because of the mutual interests and curiosity of their scientific communities to get some insight into what was a sensitive area for both the countries. In the process they insulated the joint exercise from their political problems as reflected in the mutual suspicions and the ups and downs of détente. A complex programme such as Apollo-Soyuz cannot be turned on and off. It has to be carried out consistently and steadily over four or five or more years. It was thus both a technological and a diplomatic task to insulate the Apollo-Soyuz agreement from other aspects of US-Soviet relations. Similarly the Soviet recognition of the Federal Republic of Germany some years ago had a curious scientific angle. The Soviet Union wanted the titanium technology developed in the Federal Republic of Germany mainly for use in its space and aircraft industries. West Germany decided to use technology as a bargaining counter and secure recognition from the Soviet Union. The Soviet Union in its turn insisted on the recognition of West Germany's recognizing the German Democratic Republic. Both nations got what they wanted.

Indian diplomacy has suffered from the limitation that there was not enough science and technology help or assistance available to the Ministry at the time of Independence to devote to international purposes. However, there has since then been an enormous growth of science and technology within the country, especially during the last twenty-five years; so much so that the country now ranks third in scientific and technological capabilities. There is already some significant effort to export technology, by both private and public enterprise, and on the Governmental level. There is also an effort to work in partnership with another developed country to set up manufacturing facilities in a third developing country. While the Ministry of External Affairs gives its blessing to these various efforts, it has yet to take cognizance of the possibility of harnessing science and technology to its diplomatic objectives in a consistent and long-range manner. A few years ago it made its first attempts at information-seeking by initiating the process of positioning of Scientific Attaches in our embassies in the United States, the United Kingdom, the Soviet Union, and Japan. There has not yet been a significant follow-up of this first step although the first step was taken a few years ago.

There are perhaps several reasons why, in spite of the many facets of science and technology that we have come across in our foreign relations, the Ministry of External Affairs has not been able to develop a forceful and consistent foreign policy with regard to science and technology. And
awareness of the role of technology in foreign policy with regard to nuclear matters developed early, thanks to Homi Bhabha and Nehru, but our nuclear foreign affairs were dealt with separately by the Department of Atomic Energy, thereby creating in the Ministry of External Affairs a certain antipathy to dealing with technological situations. The service bureaucrats in the Ministry were to an extent also unfamiliar with the new dimensions of technology and often missed their implications for furthering marginal sophistication in our foreign policy. For example, issues such as artificial satellites, spies in the skies, and ground truths did not create any anxiety to understand their overtones in international affairs or in national issues. Similarly export of minerals such as mica, manganese, and iron-ore was not used to strengthen the national technological base or to protect long-term national interests.

There was, besides, no structure in the Ministry of External Affairs to act as a consultant and guide and to help the bureaucracy and policymakers in anticipating issues, in keeping themselves abreast of the changing state of technology in the developing and the developed world, or in estimating our own strengths and weaknesses.

Finally we had no clearly articulated foreign policy with regard to science and technology. What were our priorities? What did we seek from the rest of the world, particularly the developed world? What were we capable of giving, or willing to give, in return to the developing and to the developed world? What sort of science and technology do we need in our foreign policy delineation in India? Do we imitate the precedents of the United States or the United Kingdom or the Soviet Union? Or do we strike out on our own? A little thinking would show that we really cannot imitate those precedents. Our constraints, traditions, technological status, and resources would not allow us to imitate successfully. However, these are the common points for consideration of all scientific policies connected with our foreign relations. To deal with such a wide range of topics which embrace many national and international issues a systematic approach to policy matters is necessary. This means a structure of some sort which can receive and process information. A sound information system is a basic requirement. For the purposes of a Foreign Office, both information flows and deliberate collection have to be ensured. The Science Attaches are another source. Published material, such as scientific journals, reports, and newspapers, has also to be scanned. Information can also come usefully from our scientists working in our universities, research institutions, and Government laboratories or from those working abroad.

The collected information has to be collated, selected, and systematized. This collation, selection, and systematization should be one of the main tasks of a scientific bureau in the Foreign Office. Only those
working in the Ministry of External Affairs are aware of the needs of the Government and the orientation of future policy. The collation and systematization has to be deliberately geared to these ends. The bureau would need guidance in terms of policy requirements, but a well-run bureau can bring to the notice of the Ministry important new features and events. It can also indicate new directions and the changes likely in the technological situation and enable the Ministry of External Affairs to be prepared for them.

The next stage in the work of the bureau in the Foreign Office would be to make assessments and evaluations of the technology and resources of the countries we are dealing with in connexion with our own interests and other aspects of our relations with those countries. Such evaluation would include useful comparisons, areas of complementarity, advantages or disadvantages of resources, and relative position in the world technology system in all the areas of importance. Such assessments or evaluation of technology and resources have to be analytical to give some force of predictability on which the Ministry of External Affairs may depend in formulating policies that will have some staying power. In relation to such assessments the problems of Indian resources and technological directions may have to be clearly enunciated and juxtaposed so that the policies take into account our possible needs and the priorities of the future.

At the next stage the integration of science and technology objectives with other aspects of foreign relations has to be ensured so that an integrated foreign policy of the country may develop. In the execution of policy, however, back-up requirements of the scientific manpower of the bureau would often be called for. What is equally important, however, is a continuing review, study, and evaluation of policies with regard to binational or multinational relations and to note the progress, particularly of their scientific and technological components, in relation to expectations. If the benefits expected are not accruing, or if there are difficulties or problems, then studies need to be undertaken to find out what has gone wrong either in formulation of policy or in implementation. Such studies are valuable in correcting errors or refining policies. They can also bring out inconsistencies or contradictions between the science and technology policies and other aspects of policy and ensure that the various policies are at all times well co-ordinated. All of these tasks from information to review of implementation constitute a single package of considerable magnitude. To carry them out within the Ministry of External Affairs would require a complement of scientists and technologists who are capable and who can work well in partnership with the bureaucracy in the Ministry. It would take time to structure such an organization, but it is more than time that a beginning was made. There is an additional issue which has to be kept in view. If scientists and technologists become
isolated from their science for far too long, they can become stale and turn into bureaucrats. There should be sufficient flexibility in the system to enable them periodically to stay and work for some lengths of time in universities and research institutions both in India and abroad so that they may renew themselves periodically. It is possible even to conceive that many of them would wish to go back to their institutions of research and that others would take their place so that some circulation of ideas and attitudes may take place without detriment to the careers of these people.

Modern technology has made foreign policy an exercise in knowledge and sophistication—in addition, perhaps, to the classic requirements of patience and clarity. The important area of foreign policy would need much greater study by students of foreign affairs with science backgrounds to be able to appreciate and understand the nuances brought in by technology. It is not enough for the Foreign Ministries to study them in their own immediate practical interest. Studies by academics with scientific as well as foreign policy and history backgrounds are likely to be fruitful and lead to new perceptions and definitions of our objectives and improve our understanding of the policies of other countries.

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