

# Introduction

Since the beginning of the 1980s, the Western world has been riding on mounting waves of new technological innovation. There have been spectacular new breakthroughs made in advanced hybrid technologies based on microelectronics (ME), particularly in such areas as computer-aided manufacturing, the biosciences, and in the development of new materials. Coupled with these has been the huge expansion of the communications industry. These developments have set in motion a profound transformation of the industrial structure toward the services- and software-oriented type of economy now found in the West.

Unlike the technologies of the 1960s that were geared mainly toward attaining economies of scale in the smoke-stack industries, the new technologies developed in the 1980s tend toward making economies more software- or system-oriented. The single most important impetus for this new technological progress has been the new trend in the market where the needs of consumers have become diversified, nonstandardized, and quality-conscious. These changes in consumer preferences are making the product-cycle ever shorter, thus putting pressure on individual enterprises to undertake technological innovation at an increasingly faster tempo. In order for enterprises and national economies to survive the increasingly harder competition, it is imperative that they have the capabilities to develop new technologies in short span of time. They must be capable of quickly adopting the new scientific findings, applying these to their programs of technological development, and to the commodities they produce. These developmental capabilities are basically determined by the level of each country's ability to develop industrial technologies. The level of this ability crucially affects whether or not the country's economy can perform satisfactorily in the world market.

Alvin Toffler called this rapid wave of Western technological innovation the "Third Wave," and it can be asked if the socialist countries and developing countries will be able to cope with this rapid advancing wave of innovation. The Soviet Union has shown itself highly competent in basic research and in the development of basic technology in such areas as medical science and new materials, but it has not performed well in the applied sciences and in applying technology to the production of commodities and services for civilian use. In fact, the Soviet Union itself admits that although it is fairly well versed in technologies for mass production in smoke-stack industries, it has fallen far behind the advanced countries of the West in the fields of high-technology. The inability of its industrial sectors to satisfy civilian needs constitutes the most serious obstacle hindering the Soviet Union in the development of high-tech fields. This inability is derived to a large extent from the highly rigid Soviet economic system, and it is unlikely to make much headway in the high-tech fields unless it makes wholesale reform in its socioeconomic system. Seen in this light, Gorbachev's *perestroika* can be looked upon as a strategy to enable the Soviet Union to survive in the new era of technological innovation.

China, which claims to be a developing socialist country or one at the "early stage" of socialism, sees Western technological innovation as a far more serious threat than does the Soviet Union. China is particularly afraid that should it fail to catch the wave of high technology, it will be left with only two choices: either to be condemned to a state of deeper dependence on the advanced industrialized countries, or, to abhor such dependence and be forced back into a policy of self-reliance and the severance of ties with the world economic community.

In the West, a belief is gaining widespread currency that the strategy for survival lies in promoting science and technology and bringing the market mechanism into fullest possible play (by way of privatisation and deregulation). During the 1980s much the same view held sway in China where it was said that the country would have no chance of surviving in the world unless it accelerated the development of microelectronic technology and allowed the market mechanism fuller play (through introducing economic reforms).

One important factor underlying the sense of crisis now gripping China, and one which its leaders must deplore and regret, is the fact that during the ten years of the Cultural Revolution (1966–76), China ceased promoting its scientific and technological competence while the rest of the world was enjoying high economic growth.

Previously, China's science and technology had been favorably received by outsiders. In such fields of basic research as mathematics, geology, dynamics, and agricultural science, the country had a number of world-famous scholars, including Hua Luogeng, Li Siguang, and Qian Xuesen, who had made outstanding contributions over the years. In engineering, too, Chinese have made important contributions, particularly in the area of bridge and dam construction. In the research and development as well as application of advanced military

technology in such fields as nuclear warheads, computers, missiles, and satellites, the Chinese took the Western world by surprise with its rapid progress.

In the application of industrial technology, it was known that China was producing much of its own machinery and equipment. It was also known that the Chinese were making efforts to unify science and technology using Maoism as a basis, and to apply a scientific approach to production activities. The shifting of scientific and technological researchers out to points of production was interpreted as a manifestation of efforts which, like similar efforts in Japan, was meant to improve the shop floor by identifying the problems and finding the solutions on the shop floor itself. It was generally believed, moreover, that China was taking great care in its choice of technologies, choosing ones appropriate to its needs and ones friendly to human welfare which would not squander energy and natural resources and thus would serve environmental conservation.

There is no denying that China, with its fairly high competence in scientific study and advanced technology, forms a class of its own among developing countries. Nonetheless, it is also common knowledge that its overall effort in the development of industrial technology, unlike the few bright spots mentioned above, is in fact hindered by many difficulties and very retarded. It has also become clear that this underdeveloped competence of China in industrial technology is an important obstacle hindering the country's economic progress. Moreover, it is well known that the problems facing China regarding industrial technology are essentially the same as those facing the Soviet Union; and therefore, China's situation can be more properly understood when it is examined by emphasizing the similarities rather than the differences of its economic system with that of the Soviet Union.

Thus, one explanation for the underdevelopment of industrial technology in socialist countries can be found in their rigidly and centrally structured economic systems. Another explanation also often pointed out is that these countries have put excessive emphasis on developing technology for military rather than civilian use. In China's case we might add two more explanations, one being the vexing problems it has had and still continues to have as a developing country, and the other being the political and ideological misfortunes of the Cultural Revolution when so many of China's intellectuals were suppressed. Its aftereffects continue to take their toll on the country.

The American experience shows that efforts at developing technology primarily for military use can to an extent stimulate the advancement of industrial technology. In this case, the government, out of a need for national defense, has taken strong initiatives to launch and implement basic as well as applied research primarily for the development of new weapons, and the technological "seeds" developed in this process have been transplanted to the industries in the private sector, enhancing their technological competence. The second half of the process has been accelerated by the market demand pull.

In a socialist country, where such demand pull is usually absent, technology

tends to remain oriented heavily toward military purposes and seldom transferred to the industrial sectors catering primarily to civilian needs. This means that in such a society the government has to actively make up for the deficiencies of the market mechanism by consciously enforcing policies for promoting industrial technology.

Over the past thirty-odd years China has tried to devise and implement policies for promoting scientific and technological development using its series of five-year plans and other forms of long-term planning. While some of these policies have put priority on the need to nurture certain industrial sectors such as heavy industry, China has never devised a policy for the promotion of industrial technology in the true sense, such as a policy to develop the type of industrial technology that could optimize the allocation of resources. The absence of such a policy has been closely related to the characteristics of question can be asked as to what mechanism has been facilitating technological progress in China. Answering this question is one of the major purposes of the present study. Another is to clarify the characteristic features of China's industrial technology in relation to the industrialization strategies that Beijing has pursued for more than three decades.

Studies on the research and development process for industrial technology in China have fallen seriously behind similar studies for the Soviet Union. The main obstacle has been the limited availability of pertinent statistics and other documentation. Recently, however, an increasing amount of such materials have become accessible, and this paper undertakes the long-overdue task of better clarifying the process of research and development in China.

Chapter 1 describes and analyzes the present state of China's industrial structure and technology, and clarifies the stage of industrial development at which the country now stands. Chapter 2 describes the country's presently existing institutional setup for research and development, and shows where ongoing efforts at reforming this system are likely to lead. Chapter 3 probes into China's industrialization strategy as it was implemented during the 1980s. This will help identify the tasks confronting the Chinese in their efforts at promoting the development of industrial technology.