

3

Industrialization Strategy and Technological Innovation

New Technological Revolution and China

Zhao Ziyang's Speech

Alvin Toffler's book *The Third Wave* is said to have caused a shock in the Chinese leadership. Following its impact, then Premier Zhao Ziyang in October 1983 delivered a speech titled "a new industrial revolution in the world," in which he pointed out that the emergence of new technologies had given rise to rapid social and technological change, and that China would be able to narrow its gap with the advanced countries if it could succeed in introducing the recent scientific and technological achievements but would find itself forever behind the advanced countries should it fail to do so. This speech reflected the keen sense of crisis that the Chinese leadership felt over their lag in technological development.

Microchips invented during the second half of the 1960s have played the leading role in world technological innovation since the 1970s. This has been characterized by an emphasis on "lighter, thinner, and smaller" products, rather than large and heavy ones. Factory automation developed rapidly in its wake, giving rise to new automatic production systems incorporating numerically controlled machine tools, industrial robots, and automatic guided vehicles.

During the second half of the 1970s, factory automation (FA) made a new leap forward. While FA originally meant automatic control of the flow of materials, it now developed into a CIM (computer-integrated manufacturing) system, which included such upstream processes as CAD/CAE/CAM (computer-aided designing, engineering, and manufacturing) and LAN (local area network) as well as downstream processes such as computer-aided product

inspection and deliveries. The progress of ME (microelectronics) revolutionized production processes enabling a plant to produce quickly and efficiently a large variety of products each in small lots. It also gave rise to a family of highly integrated technologies including biotechnology and technologies for new materials. Microelectronics, new materials, and biotechnology will certainly emerge as the three major areas of industrial development in the 1990s, and many informed observers concur that in the coming decade the traditional manufacturing-oriented society will be transformed into an information-oriented society under the impact of these technological changes. Given the rapid rate of technological innovation taking place in the advanced countries, the Chinese leaders feared that the technological gap between China and the West might widen further. Since absorbed more than thirty years ago the state-of-the-art technology of the 1950s through construction of large industrial plants with Soviet assistance, China has never drastically renovated its machines and equipment to bring its industrial capabilities up to world standards. The "economic readjustment period" in the first half of the 1960s could have been an opportunity to replace its 1950s technology with the most advanced Western technology of the time, but that opportunity was missed, partly due to the U.S. embargo and partly because of the Cultural Revolution. Until the mid-seventies China followed a policy of concentrating resources on the military sector and pursuing extensive industrial expansion. Consequently outmoded production technology and equipment survived.

In the middle of the 1970s China had another opportunity to develop economic relations with the West. This time the opportunity was not missed, and China put its effort into replacing its 1950s technology with the standard-level technology of the 1960s. The technology imported at that time was largely for such highly capital-intensive and energy-guzzling industries as petrochemicals and steel.

While China spent the second half of the 1970s through the early 1980s struggling to master its newly imported technology, advanced Western countries were already shifting emphasis from such large and heavy energy-consuming technology to the energy-saving light and small product-oriented technology, or from traditional manufacturing to high-tech industries. The Chinese became extremely suspicious about this development, wondering if the West had not imposed on China its older technology and equipment which it was about to scrap in a new industrial restructuring. They also become anxious about the prospect that unless some new effort was made, China would remain forever behind the advanced Western countries. Worse still, another scenario projected a further decline in China's international economic position. This projection foresaw the economy becoming increasingly undermined as the new era of information-oriented economies progressed; and while China would have to continue relying on labor-intensive industries and raw material exports, Western countries would progressively develop labor- and raw materials-saving technology which

would decrease the value of two important Chinese commodities: cheap labor and raw materials. If this scenario played itself out, China could lose its bargaining power.

Zhao Ziyang's speech reflected this sense of urgency, and it kicked off a debate over China's strategy for industrial and technological development.

Debate over Development Strategy

There are three views of the industrialization strategy that China should adopt. The first puts priority on high-tech industries; the second say priority should be left on the traditional industries; the third seeks a compromise between the two.

Huan Xian, the former head of the State Council's Research Center for International Problems, is the strongest proponent of the first view. He maintains that China should procure the most advanced technologies of the world, give preference to developing advanced industries, and try to catch up with other industrial countries in a short period of time. By advanced industries he means high-tech industries involved in ME, biotechnology, and fiber optics. He gives top priority to ME-equipped industries which would serve as the core for integrated high-tech industries. Huan feels that China can technologically reequip its national economy and accelerate the development of its high-tech capacities by mastering the ME technologies.¹

The traditionalists argue back that new industries can grow only on a fully developed foundation of traditional industries. Given the still retarded development of its traditional industries, China lacks the necessary preconditions for new industries, and it would be premature to give high priority to developing such new industries.²

The third view takes a middle-of-the-road position and has been gaining support. People in this group do not see China as capable of making high-tech industries the leading industrial sector of the country before the year 2000. A present electronics, biotechnology, and new materials technology carry minor weight in China's national economy; thus China can work to develop these technologies, but it cannot hope to apply them effectively. Fiber optics is one example. China began studying this technology early in the 1970s and since then has been able to develop second- and even third-generation products. But commercial production is still a long way off. The Chinese IC industry has likewise not yet reached the mass production stage. Its products remain high-priced and technically problematic, and users do not trust them. China produces two hundred different types of computers ranging from large, medium, through small, but there is no leading model that can capture a significant share in the world market. It remains particularly weak in microcomputer know-how. China can copy foreign high-tech products and this might give the illusion that the technological gap is narrowing. But in fact the gap remains, exemplified by the

vast differences in capacity, quality, and price. These high-tech industries, even if successfully developed, will not have ripple effects, let alone locomotive effects, on the national economy as a whole because of the enormous gap between the new high-tech sector and the extremely retarded general industrial structure of the economy.

The major task facing China, therefore, is to renew the equipment of the traditional industries and improve their technological level. Emphasis should be put on the improvement of product quality rather than on simply raising productivity (the expansion of production capacity by enlarging production scale) where efforts would be financially constrained. The use of ME technologies should be promoted precisely in the process of reequipping the traditional industries. The renovation of the traditional sectors thus would create a major market for high-tech products. At the same time foreign technologies should be actively imported, beginning with mature (standard) technologies useful for traditional industries. It is important for China to take advantage of the advanced countries' economic restructuring process for its own benefit (such as importing idled aluminum refineries and steel mills from Japan).

High-tech should be developed selectively anticipating that these technologies will make up the leading industrial sector after the year 2000. The areas selected for preferential development should be biotechnology, new materials, semiconductors, computers, nuclear power generation, and space development technology. As far as possible the highest-level technologies in these fields should be imported from abroad and be coupled with corresponding domestic R&D efforts so as to enable Chinese experts to digest them.³

An achievable goal by the end of this century would be to raise China's industrial technology level to that attained by advanced countries toward the end of the 1970s or early in the 1980s. For this to be done, large-scale equipment innovation and renewal needs to be carried out by the year 2000. Efforts should be made so that all major production facilities operating in China in the year 2000 will be equal to the best in the world that were operating in the 1980s. This would mean that 65 per cent of the existing equipment should be scrapped. Especially in the machinery industry, 26,000 of the existing 31,000 types of machines (84 per cent) will have to be replaced. Sixty per cent of the existing machine tools must either be improved or replaced.

Choosing Leading Industries

The Seventh Five-Year Plan (1986–90) lays stresses building up the industrial base through technological renovation in the traditional industries. In compliance with this priority, basic capital construction investment is preferentially allocated to the energy, transportation, communication, and industrial-material sectors. This policy is directed to rectify the imbalances in the industrial structure. Beyond this immediate policy goal, however, China must also develop

a strategy for upgrading its industrial structure to prepare itself for the coming century. Thus the government has recently begun to emphasize the need to single out and nurture strategic industries following the Japanese and Korean examples.

Emerging as a keen discussion topic in this regard is on what criteria strategic industries should be chosen. One group of policymakers, learning from the Japanese experience of the 1950s, asserts that priorities should be given to those industries whose products has a high income elasticity, whose labor productivity is relatively high, and which can create many job opportunities. If these three criteria are used, then the machinery, steel, petrochemical, energy, and transportation industries (all of which are highly capital- and technology-intensive) would be grouped together as the industrial sectors deserving preferential nurturing into leading industries.⁴ However, other policymakers insist that in addition to the above three criteria, export potentiality and high value added should also be considered. According to this second group, passenger cars and home electrical appliances should also be given special consideration. Already in the Seventh Five-Year Plan, the Chinese government designated the passenger car industry as one of the "pillar industry," a demonstration of its special concern for car production.

The debate currently under way over the choice of strategic industries has close bearings on which course of development China should take, export-led industrialization or import-substitution industrialization. However, even those who favor the export-led industrialization strategy do not believe that China can immediately switch to such a strategy. What they are presently doing is critically reviewing the import-substitution strategy which China has followed so far. They point out that China's imports have increased more rapidly than exports due to the country's overvalued currency and the large gap between domestic and world market prices (the former always being higher than the latter), and that protective barriers have led to the misallocation of resources, restrained competition among enterprises, and thus stagnated technological progress. They blame all this on the import-substitution strategy and recommend that China gradually shift from its import substitution to a export-oriented strategy. As first steps, the export promotion adherents call for devaluation of the yuan, adoption of export-promotion policies (tax cuts for export products), bringing domestic prices closer to international prices, and controlled import liberalization to stimulate competition. For the time being China should designate traditional industries with comparative advantage, labor-intensive industries, as export industries, and at the same time should achieve full domestic production of cars and other major industrial products through the introduction of foreign capital and turn such industries into competitive exporters by the year 2000.⁵

The import-substitution proponents take a different view. They point out that China still is highly dependent on imports of major industrial products, including

ethylene, chemical fertilizer, steel products, passenger cars, and color TV sets. Under these circumstances, they argue, substituting domestic products for the imported ones still remains China's long-term goal. Creating export industries generating high value added and producing competitive goods would be extremely difficult as long as this backward situation persists. Their policy package includes exchange rate stability to facilitate import substitution in the heavy and chemical industries, protective tariffs, preferential allocation of foreign exchange for introduction of foreign technology, and improvement in investment environment to facilitate the inflow of foreign capital into the import-substituting industrial areas.⁶

The export-promotion adherents have a point in that they correctly identify the contradictions generated by the traditional import-substitution policy, but they fail to pay due attention to a significant characteristic of the Chinese economy: the presence of a huge domestic seller's market. The import substituters have a bigger problem, for though they might sound more realistic, they ignore the economic inefficiencies consequent of the import-substitution program and offer no credible outlook that China's foreign exchange income will increase in the future if their advice is taken.

Korea's successful industrialization might offer a model for setting out a quantum leap strategy. Korea achieved a general technological breakthrough through the creation of strategic industries and not by relying on technological accumulation in its traditional industries. The exemplary examples are Korea's shipbuilding and steel industries. In the early 1970s, the country created with Japanese assistance the most advanced large-scale shipyards and steel mills (Hyundai Heavy Industry Co. Ltd. and Pohang Iron and Steel Co. Ltd) and quickly turned them into powerful export outfits. None grew out of traditional industries. They came into exist through the transplanting of the most advanced technologies available at that time.

China is not without such experiences. Synthetic chemicals and television-set production are cases in point. Early in the 1960s China introduced a vinylon plant (the coal-carbonization method) from Kuraray Co. Ltd. of Japan, and this signaled the start of China's synthetic chemical industry. But the Cultural Revolution broke out not long afterward, and there was no follow-up for a whole decade. Later, from the mid-seventies through 1979, China imported a number of petrochemical plants from Western countries. With these plants China soon emerged as a major synthetic chemical supplier capable of emulating the top-ranking producers in the world. In television production, China imported production lines on a large scale in the early 1980s and set out to achieve full domestic production. Now China is one of the world's major TV set-producing countries.

It should be clear to all however that the major factor responsible for the vulnerability of the Chinese industrial structure is the retarded growth shown in the intermediate-goods and industrial-materials sectors when compared with

the machine-assembling sector. Given the huge demand on the Chinese market, this imbalance between the two sectors will take a long time and a huge amount of money to rectify.

Unlike Korea, China is an economy dependent on the domestic market. If it follows an industrial strategy that induces further disruption in the equilibrium of its industrial structure, this would be bound to make stable economic growth extremely difficult, make the country more dependent on imports for intermediate and capital goods, and thus make its international payments position more precarious. There is no doubt that machine-assembling industries such as automobiles and home electrical appliances are attractive to China as they have great ripple effects on the macro-economy in the areas of income, technology, and employment. But China sorely lacks and greatly needs inducements to promote inter-industry linkage. This is a problem of regional and bureaucratic sectionalism as well as the autarkic practices of industrial sectors that continue to be adhered to. No strategic industries will successfully emerge in China until and unless these negative systems and practices are eliminated.

Choice of Technologies

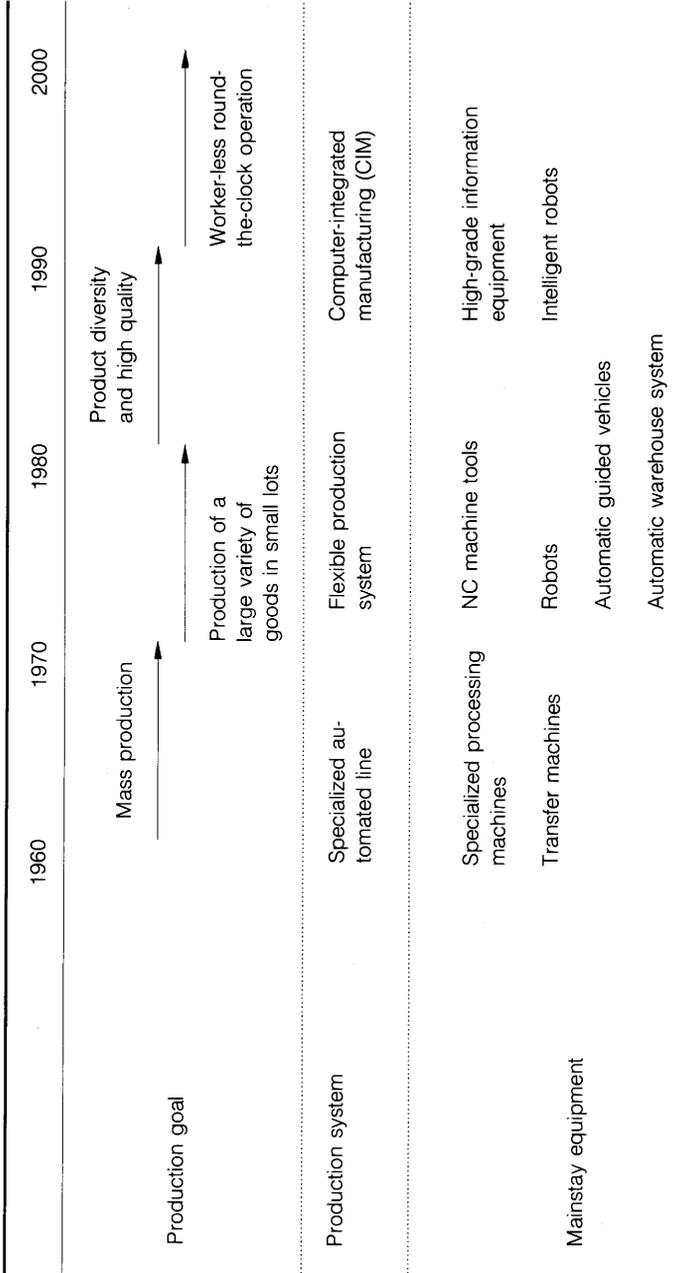
One can discern a strong sense of self-confidence and simultaneously an acute sense of impatience when one listens to Chinese debaters on economic matters.

Explaining the secrets of Japanese industrial development, Japanese scholars tell their Chinese counterparts that Japan started with the cotton industry in the Meiji period and gradually accumulated technological capacities; then after World War II Japan on the basis of these already existing basic industries was able to enter into a forward-linkage development process advancing into machine assembly and then finally into high-tech industries. Chinese listeners never concur with this logic. They are interested only in how after World War II Japan was able to efficiently acquire highly competitive steel, shipbuilding, automobile, and electrical industries in such a short period of time.

I surmise that this particular way of looking at the Japanese experience reflects their self-confidence and pride in the fact that China already has a self-sustaining industrial system, particularly a large machine industry with certain R&D achievements, which produces electronics and even satellites. As a result Japanese and Chinese scholars assess very differently the present stage of Chinese economic development.

Given this difference, it is extremely difficult to persuade the Chinese to accept the notion of appropriate technology. In selecting technologies, China has always given priority to the state goal (which has always been to catch up with the advanced industrial countries and avert technological subjugation) rather than choosing those which are best suited to its already accumulated technological heritage and which are suited to its factor endowments. China has had too many cases where the introduction of advanced technology has failed because it did not fit into the pattern of its factor endowments. In recognition

Fig. 3-1. Stages of Intra-factory Technological Innovation



of this fact, the Chinese government in recent years has begun to comprehend the notion of appropriate technology. However, at the micro level (or factory level), the idea of appropriate technology usually means a miracle technology that can drastically raise capital productivity and can convert an old factory overnight into a most advanced one.

To a large degree this attitude exemplified the goal now held in China, that of a ME revolution to convert conventional factories into high-tech facilities. Figure 3-1 shows the progress of factory automation in Japan. The ME revolution developed in Japan under the impetus of new social needs for a switch from economies of scale (mass production) to economies of range (production of diverse goods in small lots). Factory automation was promoted precisely to enable the plant to have a flexible production system that could quickly and finely adapt to the vagaries of the market and reduce the required size of the labor force to lower costs. In 1987 the Japanese labor force was reduced by approximately 400,000, most of them in the intermediary processing sectors where they had become redundant because of factory automation.

China is desperately trying not to be left behind in this ME revolution which is under way in the West. When Chinese import machines, they always demand that the machines they buy micro-computer controlled units. They are strongly interested in buying even high-precision machine tools, multifunctional systems, and other high-tech machines.

The Chinese news media are fond of miracle innovation stories: a factory in a certain region has remodeled its facilities using 1980s technology only, or another factory has greatly improved productivity by replacing its old production line with a brand new computer-controlled transfer machine. Such stories are daily fare in the Chinese press. Even CAD and CAM technologies were designated as *gongguan* in the Seventh Five-Year Plan.

Despite such displays however, the discrepancy between the goal and the reality is still very large. Table 3-1 shows the results of a survey on the degree of automation at 7,946 state-owned large and medium-size enterprises. Taking as the basis the share of automated and semi-automated production line in the fixed asset costs, it is clear that even the level of even semi-automation, let alone full automation, is still very low. Generally speaking, Chinese industry is in transition from simple mechanized production to integrated mechanized production, in other words, from the stage of introducing of power machines in the main production process to the stage where all processes are performed by machines operated by human hands. This means that computer systems can be introduced only into a limited number of plants. In 1984–86, following Zhao Ziyang's call for a new technological revolution, a large number of computers, including personal computers, were imported, but most of them remained unused in warehouses. This symbolically showed where Chinese industry now stands.

In production methods China has been for some time producing "a large variety of products in small lots." But unlike the Japanese case, this means

TABLE 3-1
STATE OF AUTOMATION AND SEMI-AUTOMATION, 1985 YEAR-END

	(1) Value of Fixed Assets in Machines and Equipment (100 Million Yuan)	(2) % of Automated Production Lines in (1)	(3) % of Computer- controlled Lines in (2)	(4) % of Semi- Automated Production Lines in (1)	(5) % of Computer- controlled Lines in (4)	(6) Aggregate % of Automated and Semi-automated Production Lines
7,946 enterprises	2,187	0.57	63	2.3	34	2.89
Large enterprises	1,474	0.74	68	2.7	41	3.45
Medium-size enterprises	712	0.20	25	1.5	6.8	1.72
Light industry	364	0.46	5.6	3.0	4.5	3.44
Heavy industry	1,822	0.59	72	2.2	42	2.78
Iron and steel	258	2.13	98	9.9	58	12.02
General machinery	245	0.28	16	0.98	2.4	1.26
Transport machines	97	0.51	74	1.4	0.5	1.94
Electronics and communications equipment manufacturing	36	0.53	4.6	13.1	26	13.64

Source: Leading Group of National Industrial Census under the State Council, *Zhonghuanrenminggongheguo 1985 nian gongye pucha ziliao* [Industrial census of the People's Republic of China, 1985], Vol.1 (Beijing: Zhongguo-tongji-chubanshe, 1987).

Note: This table is based on the industrial census of 1985, which covered 7,946 of the 8,285 large and medium-size state-owned enterprises. The automated and semi-automated production lines do not include various semi-automated systems used by the petrochemical industry, nor NC machines used separately in such production processes.

that China has a huge number of small factories, each separately producing different goods. During the 1980s, China reached the stage where it began dealing with the problems of mass-producing standard products. This stage has required China to introduce specialized processing machines and transfer machines to replace its traditional versatile machine tools.

High-tech equipment and ME technology is by nature labor-saving, but as Western specialists, including this author, have learned on visits to numerous Chinese factories, labor-intensive technologies are still employed side by side with advanced labor-saving technologies, even at technologically advanced plants. For instance, at plants making large machine tools using advanced automatic production control, the movement of finished and semi-finished products, the adjustment of machine errors, product inspection, and other auxiliary jobs are still done manually. Those processes which do not require high mechanization and standardization seems to be deliberately left labor-intensive. The reason for this is because factories have to employ too many workers, especially unskilled laborers. Workers are allocated by administrative agencies, and management has no power to hire or fire workers. Under this system the enterprise's effort for labor-cost saving has an absolute limit. Given this limitation, management tries to raise productivity not by saving labor but by raising machine and equipment productivity. Thus the primary motivation for a Chinese factory to introduce ME technology is to expand its production capacity and improve product quality, and not to save labor.

But this coexistence of automated and manual processes in the same factory seems to be a factor contributing to the lack of proper rhythms and cycles in the production process which in turn helps explain the low production efficiency of Chinese factories.

Many Japanese experts have already pointed out that the Chinese factory has plenty room for higher productivity without introducing advanced machinery. This can be achieved through improved management methods, including more innovative labor organization, layout rationalization, the introduction of proper incentive systems, and enhancing worker skills. Without improvements in these areas, the introduction of costly ME systems will not be rewarding.

Economic Reform and Technological Innovation

Pressures for Technological Innovation

China's policy goals for the 1980s were to promote effective application and "commodification" of technologies and to prepare enterprises for technological innovation. The Party Central Committee's decisions on the reform of scientific and technological system adopted in 1985 were the initial measures taken to strengthen linkages between science and technology, research and production, and between basic research and application research, through reforms in

the R&D systems. But improving R&D at the enterprise level required general reforms in economic management. We will examine how the economic management reforms have been influencing enterprise-level R&D.

Too great a concern for growth usually sidetracks attention from technological innovation. During the economic reforms of the 1980s, China became more strongly growth-oriented than before. The decentralization of economic decision-making powers after 1978 activated the macro-economy insofar as it entailed deregulation of economic activities. But in the absence of proper macro-level controls, the same policy was responsible for disruption of economic equilibrium and subsequent economic disorder. Allowed to retain a certain portion of their profits, the enterprises, local administrative units, and other economic units were able to increase funds at their disposal. The funds thus accumulated were appropriated in two ways. One was that a higher percentage of profits began to go to workers in the form of bonuses. This suddenly expanded workers' income and caused a consumption boom. However the supply capacity was not sufficient which led to the creation of excess purchasing power. Another was that local governments rushed to invest whatever surplus funds they acquired in consumer goods production. This was in reaction to China's "investment hunger," a phenomenon that had previously existed due to the government's centralized economic policy. This rush was apparently to take advantage of the new buying spree, for not only local governments but also urban private enterprises (now permitted to exist under the deregulatory measures) as well as numerous village and township enterprises in rural areas all joined in the investment rush. After 1985 industrial output continued to grow at a record 15 per cent per annum reflecting excess investment in manufacturing. Such overheating however never fails to distort the industrial structure. While the processing sector grew enormously, there was insufficient investment in energy, raw materials, transportation, and other infrastructural sectors. This aggravated imbalances in the industrial structure and caused general shortage of goods.

Inflation was triggered both by demand pull and cost push due to shortage of materials. The price index jumped annually by 15 per cent. The government enforced money-tight measures more than once, but decentralization had already weakened the central government's power to control. Thus government policy failed to serve as an effective brake, and inflation has continued to this day. This has created a very difficult environment for enterprise reforms which nevertheless have to be carried out.

The scope of compulsory planning, was drastically reduced during the economic reforms of the 1980s. This change has forced enterprises to transform their behavior. The survey on state-owned enterprises in Tianjin, cited in Chapter 2, showed that 59 per cent of them no longer received any directives involving compulsory planning; for collective enterprises the corresponding figure was 70 per cent. Compulsory planning still weighs heavily on the metallurgical and automobile industries, both which continue to suffer from shortages of supply.

TABLE 3-2
SOURCES FOR MATERIALS OF THE 300 ENTERPRISES IN TIANJIN (%)

	State-owned	Collective	Joint Venture	Private Ownership
Supplied under compulsory planning	38	30	16	0
Inter-enterprise purchase or exchange	10	10	10	4
Purchased on the market	49	57	73	95
Other ways	3	4	1	1

Reduced compulsory planning means that enterprises have to change their procurement sources. Table 3-2 shows the sources for procuring materials of the 300 enterprises in Tianjin. Even the state enterprises received only 38 per cent of their necessary supplies from the government, and purchased about 50 per cent on the market. As supply of materials became tight in the wake of the national investment boom, most of the 300 enterprises in Tianjin complained about procurement bottlenecks.

With compulsory planning being phased out, enterprises now have to make their own production plans independent of national planning. The state also no longer automatically buys up their products, so enterprises are now required to make hitherto unknown efforts at marketing. This change in circumstances has exposed them to competition, an entirely new experience. Enterprises now find market information, not the production directives, to be their most important guideline for operation.

The Chinese consumption boom in the 1980s has a peculiar characteristic: for a country with a per capita GNP of U.S.\$300, the consumption pattern is incredibly high-graded. In urban areas there is an oversupply of goods at the mature stage of the product cycle, such as spring-driven wrist watches, vacuum flasks, bicycles, black-and-white TVs, electric fans, sewing machines, and other widely used household articles. At the same time there is strong demand for color-TVs, digital watches, radio-cassettes, refrigerators, and washing machines, all products still at the juvenile stage in China.

This upgrading of consumer demand patterns and an already emergent oversupply of some low-grade consumer goods certainly exerts pressure on enterprises and act as a stimulus for technological innovation. Electric fans are a good example. In the early 1980s, some three thousand enterprises went into the production of electric fans and increased output to 30 million units a year, apparently an oversupply situation. By 1987 the electric fan market had become a buyer's market. Consumers became selective, and many small fan makers disappeared. Only technologically superior enterprises who impressed the consumers with their brand names succeeded in surviving. Having gone through the ordeal of the market, these few fan makers are now exporting more than one million units to other countries.⁷

Electric fans are an exceptional case however. Instead of letting the market decide, the government usually intervenes to regulate excess competition. Official policy is that not all goods should be treated like fans.

For the ongoing market reform to begin working as a stimulus for technological innovation, a number of obstacles will have to be removed. The first is the strong power wielded by local administrations, mainly the municipalities, over the management of local enterprises. A local government tends to regard local enterprises as easy money sources. In order to maximize sources of income, local governments will prohibit entry into their individual jurisdictions of goods from other areas, or will take other protective measures (tax exemptions and compensation for deficits) for local enterprises. In such cases, the local governments absorb competitive pressure against their own local enterprises and prevent competition.

The second obstacle is the tendency of enterprises to avert risks involved in new product development. This occurs under a specific set of circumstances: the market belongs to the seller for most products, the price system does not faithfully reflect the supply-demand situation, and market information does not freely circulate beyond sector and regional barriers. In short, the market is still imperfect. Under these circumstances, an enterprise can make tolerable profits simply by making and selling standard products. Development of new products would be necessary if the enterprise wanted to maximize profits, but that would entail risks, and a failure could result in salary cuts.

Entrepreneurship

The major obstacle to be overcome, however, seems to involve the relationship between government administrators and the enterprise. To stimulate technological innovation, the enterprise should be clearly separated from government administration, and the autonomous decision-making power of the enterprise to manage its affairs has to be established.

At present enterprise reform is concentrating on the introduction of the management responsibility system. Under this system the head of an enterprise signs a contract with the higher administrative agency stipulating the quotas to be fulfilled and the profits and taxes payable to the authorities. The head of the enterprise thus assumes the responsibility to fulfill the contract. If the targets agreed upon are overfulfilled, the differential is distributed to the enterprise head and his/her workers in the form of bonuses. For underfulfilled contracts the differential is subtracted from the head's salary.

Going back to the Tianjin survey, 82 per cent of the 300 enterprises follow the management responsibility system. This system is a step forward from the previous one in that the manager now has more responsibility as well autonomy. However, there are serious limitations. The major problem is that under this reward or punishment system the head of the enterprise naturally pays attention to short-term, tangible achievements and avoids making steady, long-term efforts for technological progress. The administrative agency in charge

still uses the traditional evaluation measures—total output value, total output volume, and profit—when judging an enterprise's performance. The enterprise head thus is interested only in raising the output value and volume from the previous year, and remains indifferent to technological innovation and improvement.

No less serious is the administrative intervention in the affairs of the enterprise. Afraid that the same person staying as head of an enterprise for too long might acquire too much personal power over state properties, enterprise heads are limited to terms of three or four years at the longest. Administrators also interfere with the distribution of profits to different enterprise funds (the fund for production development, the fund for promotion bonuses, the welfare fund for staff and workers) and thus control the enterprise's investment, fund distribution, and development policies. Enterprise heads appointed by government bodies are under the restraining power of their respective bodies. Table 3-3 provides data on these appointments and indicates the pervading power that administrators continue to maintain over enterprises. It is understandable that the state would appoint heads to state enterprises, but it is surprising that even for collective and joint-venture enterprises more than half of the heads are appointed by administrative agencies. Even at village and town enterprises, considered the most responsive to the market mechanism, most enterprise heads are appointed by administrative agencies (by village or township administrative units in this case). The administrative units thus have almighty powers over the enterprise heads irrespective of the form of ownership. This is another indication of the formidable power exercised by Chinese administrators.

Of the enterprise heads covered by the Tianjin survey, as many as 297 said they had little autonomous powers. The acutest complaints were about their insufficient powers over staffing and finance. According to the Economic System Reform Institute of China, over 80 per cent of the country's enterprises already follow the management responsibility system, but the institute admitted that few of them had actually been given autonomy. In fact the institute takes a rather pessimistic view of the situation saying that the fundamental problem is that in an economy of scarcity the distribution of precious raw materials will be controlled by the government, and as long as this remains so, it will be very difficult to completely separate the enterprise from government administration.⁸

In the situation, the enterprise heads suffer all the hardships under the management responsibility system. He/she may be rewarded or punished depending on whether the contract with the higher administrative unit is fulfilled or not. Along with the pressure from above, the communist Chinese enterprise ideology that the workers are the masters of the factory empowers the trade union and workers' assembly to deal with and put pressure on the management. Driven by the strong *panbi* ("equality with others") spirit, workers can bring pressure

TABLE 3-3
THE METHOD OF APPOINTING HEADS FOR THE 300 ENTERPRISE HEADS IN TIANJIN (%)

	All Enterprises	State-owned	Collective	Village & Town	Joint Venture
Appointed by agency in charge	85	97	77	72	57
Publicly recruited	8	2	12	21	43
Elected by workers	7	1	11	7	0

TABLE 3-4
THE WILLINGNESS OF ENTERPRISE HEADS TO CONTINUE IN THEIR POSITIONS
(from the survey of the 300 enterprises in Tianjin)

	All Enterprises	State-owned	Collective	Joint Venture	Private
Willing (%)	50	37	63	60	100
Not willing (%)	50	63	37	40	0
Total answers	290	149	126	10	5

Note: 290 respondents.

to bear on management for higher wages and better welfare conditions no matter what their enterprise's performance may be. Thus enterprise heads are often sandwiched between the pressures from above and below and harassed handling immediate issues. They have little time to think about long-term goals. Asked if they cared to continue as enterprise heads after expiration of their terms, many answered negatively, particularly in state-owned enterprises, as indicated in Table 3-4.

"The Third Wave" and China

Since liberation China, as a developing country, has spent a disproportionately large amount of money for the promotion of science and technology. This has been primarily for strengthening its national defense capabilities. Science and technology have thus been integrated with national defense needs, and fostered as a special sector for which the state has been fully responsible. It was not the demand of the market that prompted the development of science and technology; the logic of demand-pull had not been at work. This being the case, it is no surprise that the linkage between R&D and civilian industries has remained weak. But in the defense sphere the situation is quite different. Forty years after liberation there can be no doubt that China has made tremendous technological progress within its weapons-heavy industry complex. Not only has China come abreast of the advanced countries in the production of advanced weaponry, but it has also succeeded in building significantly large automobile,

steel, and shipbuilding industries by mastering the basic technologies of these industries.

Nevertheless, this self-reliance has been achieved at the expense of suppressing mass consumption. This weakness was laid bare the moment mass consumption exploded in the 1980s following exposure to the demonstration effect of consumer goods brought in from abroad.

China failed in building up sufficient domestic supply capacity primarily because modern production systems were not yet firmly established. Automation and mass production technologies still remain backward and the industrial sectors producing industrial materials and intermediate goods are not yet mature. In the 1980s China adopted an open-door policy, and as a result was brought face to face with the stark fact that there were no Chinese industrial commodities with export competitiveness; worse still it saw clearly that it lacked the capacity to develop new competitive products. The Chinese leadership was shocked by Toffler's "Third Wave" because after reading the book they realized that China had not yet even gone through the "second wave," or the period of industrialization characterized by heavy industrial development and mass production. This at a time when advanced countries were already beginning to deindustrialize. They also realized with a keen sense of alarm that while product cycles in the advanced countries were becoming ever shorter due to the rapid pace of technological innovation, China's industrial R&D capacities were performing at an appallingly slow pace.

State-owned enterprises, spoiled by long-standing administrative control practices, are now incapable of independent thinking. Creative managers with entrepreneurship are now few and far between after years of rampaging leftist extremism, and there is no longer any institutional system working to encourage enterprises to take a real interest in promoting their own R&D.

Growing extremely impatient with its situation, China attempted to jump on the Third Wave. This led to excessive technological dependence on the West. Generally, Chinese enterprises tend to try to compensate for their R&D weaknesses with imported western technology. This tendency peculiar to Chinese enterprises quickened as decentralization policies loosened the grip which the Ministry of Foreign Economic Relations and Trade had long held on enterprise behavior. During the 1980s China imported a wide selection of goods from the West, ranging from complete industrial plants and home electrical appliances assembly lines to personal computers. The imported products added to production capacities especially in the fields of consumer goods, but disorderly importing dealt blows to local infant industries. And as happened in the past, the bulk of the imported equipment has been left idle in warehouses.

China held high expectations for foreign investment. Foreign direct investment was regarded as an important channel for technology transfer and a means of promoting exports. After 1979 the number of ventures and the total amount of investment did grow rapidly, but most of the foreign capital went into hotels

and other service industries. The manufacturing sector failed to attract the expected amounts of foreign investment. The domestic support system also proved inadequate, and joint ventures had the adverse effect of increasing industrial-material and parts imports.

These various negative consequences were brought about by the open-door policy which originally had been intended to facilitate induction of Western technology. Chinese conservatives pointed to these negative aspects and started to attack the system. Finally reformers in the leadership had to give warnings against excessive dependence on imported technology.

Inflation seems to be an unavoidable companion of economic reform and puts a brake on reforming efforts as can be seen in the East European countries. Especially in a low-income country like China, the leaders have to be extremely cautious about a price reform that can cause disastrous inflation. Everyone admits that China needs a price reform, but there seems to be no consensus about the pace at which it should be carried out. The quickening pace of price increases during the second half of the 1980s caused China's leadership to partially freeze its price reform program, and it still remains in this practically frozen state.

At present reform efforts are concentrated on management systems for state enterprises. The State-owned Enterprise Law was enacted in June 1988 to separate government administration from the enterprise and to impart on the latter status of a juridical person. On the basis of this law, the Enterprise Bankruptcy Law was then adopted. The already mentioned management responsibility system is now in operation and clarifies the personal responsibilities of the head of an enterprise.

The remaining problem is to carry out a reform of the work systems. The target has been already identified; putting an end to the *tiefanwan* ("iron rice bowl") practice, or the life-time employment system and other related practices. Singled out for abolition are the guarantee of fixed wages irrespective of enterprise performance (enterprise profits and the total wage paid are not now directly linked now) and fee-free social insurance and welfare systems. Past reforms tended to unilaterally emphasize material incentives to workers, but now a whip too is considered necessary.

Since 1985 the traditional full-time worker system has been gradually phased out and replaced by a contract system. New recruits are all contract workers. To raise productivity the enterprise now decides on regular personnel strength and transfers surplus workers to other jobs or enterprises. Hopelessly incapable workers are even fired. Free medical care and other social security measures have been discontinued at some enterprises.

Naturally workers resist such reforms, and it is still anybody's guess what the fate of the work system reform will be. These reforms might whip the enterprise into increasing productivity, but it is doubtful if these will act to increase the enterprise's interest in technological innovation. Administrative

pressure to make enterprises attain a quantitative target is usually counterproductive in stimulating technological reform. Our opinion is that more latitude for enterprises plus proper competitive pressure would be helpful in stimulating their willingness for technological progress.

Since 1988 the central government has been implementing its "coastal areas development strategy" as a new means for technology induction that is intended to prevent foreign exchange difficulties. According to this strategy, labor-intensive industries employing 180 million workers from the countryside will be built in the coastal areas which are to act as major export bases facilitating foreign exchange acquisition. At present a horizontal and intra-industry division of labor is developing in East Asia involving Japan, the Asian NIEs, and ASEAN countries. This process has been enhanced through direct investments and facilitated by the strengthened exchange positions of the Japanese yen, Korean won, and Taiwanese yuan. China hopes to participate in this division of labor and thereby enable its coastal areas to experience NIEs-type development.

Considering that China needs to import large quantities of capital goods for economic modernization, offering local labor and functioning as a subcontractor for foreign manufacturers may be a rational choice. And in fact, given a certain amount of time, China's coastal areas might be able to make NIEs-type export-led growth. However, there is strong opposition to this strategy. These opponents are divided into two groups. One warns that if this strategy is carried out, China's inland regions as the major industrial base and raw material source may be left behind. The other group fears that the strategy could doom China to a level of labor-intensive-industry-oriented development at a time when technological innovation is accelerated worldwide. The first group resists the coastal strategy in favor of a self-reliant industrialization policy, while the second represents the views of those who say China must catch up with the Third Wave.

In order to satisfy both sides, the Chinese leadership is presently emphasizing that China's manufacturing industry will soon be equipped with advanced production systems based on the newest information technology (micro-computers and optical communications). Active introduction of high-tech systems may help enhance the political prestige of China's leaders, but these will not offer real solutions. Far more important issues confront China today. It must have more respect for science and rationality, and more respect for experts, opportunities for the talented, stimulus through competition, a keener sense of urgency for technological innovation, and a social system that will guarantee all these.

Since writing this chapter, China has gone through the big upheaval of the Tian'anmen Square incident on June 4, 1989. In the aftermath, the reform-minded Zhao Ziyang was purged and conservative leaders reemerged. The outcome of these events has not simply brought about political changes, but had

resulted in a shift of China's development strategy as well. The government has already suspended its price reform efforts and has begun implementing an economic policy of austerity. At the same time one hears no more talk about an export-led industrialization strategy with priority on embodied export potential and high value-added industries such as passenger cars and home electrical appliances. Instead the traditional industries (iron and steel, petrochemicals, energy, and other material industries) have again become the focus of industrial policy, and the new conservative leadership has redirected emphasis back to import substitution in these traditional industries.

Considering the state of the Chinese economy, suffering as it has been from inflation and serious structural imbalance due to overheated economic growth during the 1980s, this shift of strategy reflects a certain amount of short-run economic rationality. But the new leadership has not yet come to grips with China's need for a long-term development strategy, mainly because no one is yet assured of the country's political stability in the coming years which will be a prerequisite for economic modernization. There also seems to be a growing mood of pessimism among the Chinese people which has made less enthusiastic about the modernization line of the 1980s, due largely to their reaction to the political setbacks following the Tian'anmen incident. It will be China's great misfortune if the country fails to overcome this pessimistic moods and China's new leadership will be greatly remiss should it fail to cope with the enormous technological changes taking place in the world around China, and which are propelling the Asia-Pacific region into the front ranks of the industrialized world.