CHAPTER XI

Western Technology in the People's Republic of China

CONTENTS

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THE HISTORY OF TECHNOLOGY IN CHINA

PREREVOLUTIONARY DEVELOPMENT

During the past 300 years, technological progress flourished in Western Europe and North America while China languished. That China was for so long bypassed by technological progress **is one *of* history's great ironies, for few countries can match its long-term record of inventiveness and technological sophistication. There are many familiar examples of Chinese inventiveness including gunpowder, paper, and the compass. To these may be added many diverse artifacts and techniques, including oil refining, the chain-drive transmission, the segmental arch bridge, iron casting, the differential gear, deep drilling, the piston bellows, and the stirrup.* The sophistication and richness of early Chinese civilization staggered all who came into contact with it.**

This outpouring of sophisticated techniques and devices resulted in significant changes in productive, military, and commercial activities. The introduction of new crop varieties and new strains of established crops had enormous repercussions, allowing the settlement of frontier areas to the South and permanently shifting the demographic center away from the former heartland of the Yellow River basin.[2] Use of the compass, along with fundamental innovations in shipbuilding and sailing techniques, led Chinese navigators perhaps beyond the Arabian Peninsula. Improved roadbuilding techniques and bridges of every description knitted the empire together and put every major city in regular communication with the imperial capital. In sum, traditional China went through many changes as new technologies elicited responses in productive efforts and administrative capabilities. This occurred despite substantial inertia created by established cultural and bureaucratic structures.

But while technological development provided a secure foundation for the governing elite and the civilization they created, new ways of doing things did not alter customary societal and political arrangements. In sharp contrast with the history of Europe, technological changes were not associated with fundamental changes in the social order or the rise of new classes that could threaten the existing order. Merchants remained politically and culturally subordinate, and Chinese cities remained firmly under the control of the existing Mandarin elite.

The traditional cultural and political system demonstrated a remarkable resilience in the face of extensive technological changes; the Confucian culture was deemed more valuable than the products of a new technology. Moreover, the cultural hegemony of Confu-

[1] See Joseph Needham, "Science and China Influence on the World" in Raymond Daw son, ed., *The Legacy of China* (London: Oxford University Press, 1964).

[2] Ho Ping-ti, *Studies in the Population of China, 1368-1953* (Cambridge, Mass.: Harvard University Press, 1959), pp. 169-'76; 1 83-92.

cianism helped to retard technological progress; the mental patterns fostered by the study of the Confucian classics were at considerable variance with those appropriate to the continuous development of new ways of doing things. Although there was not always outright hostility to technology, active involvement in technological matters fitted poorly with the dominant culture. It induced a reluctance to become involved with innovations of any sort, particularly those that centered on the improvement of menial existence.[3]

The literary and bookish nature of the elite culture in China stood in clear contrast to the empirical, practically oriented spirit necessary for the development of new technologies. The content of Confucian philosophy was not conducive to a spirit of conquering nature through the application of new devices and techniques. The primary concern of the scholar and the putative role of the official centered on learning the correct principles of human relationships, and using these principles for the maintenance of harmony, both between man and man, and man and nature. In contrast, technological change by its very nature disrupts existing relationships and dissolves harmony. Whatever the practical benefits of technological change, the disruption of the existing state of affairs could hardly be applauded by the traditional official who had been schooled in Confucian philosophy.

> In sum, therefore, the main inhibiting cause (for the lack of development of science and technology) was the intellectual climate of Confucian orthodoxy, not at all favorable for any form of trial or experiment, for innovations of any kind, or for the free play of the mind. The bureaucracy was perfectly satisfied with traditional techniques. Since these satisfied its practical needs, there was nothing to stimulate any attempt to go beyond the concrete and the immediate.'

When stimulation to technological advance did come, it came in the form of a profound external threat. Technological stagnation was never absolute in China, but it was most sharply revealed when the Western powers attempted to extend their influence there. From the point of view of the West in the 18th and 19th centuries, China was poor, ignorant, and backward. It was China's misfortune to be in a period of dynastic decline during the time that an aggressive West (and later, Japan) bolstered by formidable technological prowess, was extending its influence across the seas. The technological stagnation that afflicted late traditional China might have continued were it not for the intervention of the West; indeed, it can be argued that the shock of Western and Japanese domination was essential if China was to rejuvenate. But China's inferiority to foreign powers left an enduring sense of powerlessness and debility; the development of technology became an indispensible part of efforts to regain a modicum of security and independence, especially relative to those nations that took part in its subjugation and humiliation.

The application of new technologies was essential to this endeavor. This in turn necessitated a greater receptiveness to ideas, processes, and materials that had been developed elsewhere. But nagging doubts attended the effort to transform China's technological order: could foreign products and techniques be adopted without their bringing a profound dislocation to Chinese culture? The answer was negative. Achieving a rapprochement between imported modernity and indigenous patterns of life proved difficult; technological progress could not be pursued in disregard of the cultural consequences. China's recent history can thus be seen as the search for "modernization with pride."[5]

[3]See Liu Ta-chung, "Economic Development of the Chinese Mainland, 1949-1965" in Ho Ping-ti and Tang Tsou, eds., *China's Heritage and the Communist Political System* (Chicago, Ill.: University of Chicago Press, 1968), pp. 134-5.

[4]Etienne Balazs, *Chinese Civilization and Bureaucracy* (New Haven and London: Yale University Press, 1964), p. 22.

[5]See Joseph Levenson, *Confucian China and Its Modern Fate: A Trilogy* (Berkeley and Los Angeles, Calif.: University of California Press, 1968).

The evident military superiority of the imperialist powers jarred the Chinese ruling elite into the realization that some adjustments would have to be made, and that the foreigners would have to be met by equivalent military strength. No serious ideological obstacles stood in the way of this; even the most conservative Confucian official recognized that military defense was a legitimate area of interest and concern.

Modern science and technology thus found their first home in China in the shipyards and armories established to counter the might of the West. A new generation of engineers, technicians, and scientists began to be trained in the Government's arsenal, where, after 1865, foreign instructors schooled their Chinese pupils in modern shipbuilding, metallurgy, and arms manufacture.[6] Despite earlier Chinese advances in nautical architecture, explosives, and ordnance, a new set of skills had to be developed as China attempted to preserve its national and cultural integrity.

The realization that improvements in defensive capabilities could not be pursued in isolation from other modernizing currents came slowly. At first, each step of military and technological modernization was justified in terms of its immediate importance for keeping out the foreigners. But the fact remained that the development of weapons and other items of military technology required at the least such supportive industries as railroads, steamships, and coal mines.[7] For "progressive" Chinese thinkers, the assimilation of Western science and technology took on an importance which transcended the strengthening of the military and its supporting infrastructure. Science and technology were to be the foundation of a new Chinese society erected on the remains of a crumbling civilization, and scientific inquiry and rational thought became "slogans in an anticlerical war against superstition and authority."[8] Even after the collapse of China's last dynasty and the establishment of the Republic an aggressive belief in the intellectual and spiritual superiority of scientific ways of thought continued to challenge traditional religious and philosophical beliefs.'

There could be no easy incorporation of scientific thinking or technological application into the corpus of traditional Chinese elite thought and culture. Effecting the necessary changes in the basic elements of the traditional order posed a great threat to many Chinese, especially those whose self-identity and authority were bound up with the Confucian world view. The development of modern ways of doing things could not be initiated without thoroughgoing changes in Chinese culture and society, and the techniques necessary to preserve Chinese national integrity from the onslaughts of the West would paradoxically result in the complete conquest of the traditional way of life. The fact that the conquest would come from within would make it no less complete.

Some Chinese, however, endeavored to have it both ways, seeking to retain the essential features of Chinese civilization while at the same time acquiring and assimilating the foreign technologies necessary for China's resurgence. According to their prescription, new technologies and organizational structures could be incorporated for their utility, leaving unchanged the essence of Chinese civilization. The surface plausibility of this synthesis was quickly challenged by the more unregenerate members of the Chinese political and cultural elite. To them, a China that took the path of technological and organizational modernization would soon lose its way in its pursuit of foreign

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'Charlotte Furth, *Ting Wen-chiang: Science and China New Culture* (Cambridge, Mass.: Harvard University Press, 1970), p. 11.

'Albert Feuerwerker, The Chinese Economy, 1912-1949 (Ann Arbor, Mich.: University of Michigan Center for Chinese Studies, 1968), pp. 1-2.

*Furth, op. cit., p. 70.

[9]C. K. Yang, *Religion in Chinese Society* (Berkeley, Los Angeles, and London: University of California Press, 1970), pp. 363-7.

novelties: a commitment to acquire and assimilate modern technologies could only result in the dissolution of the established culture. These qualms were not enough to stem the tide of change, and there was little chance that the Confucian elite could maintain the world in which they had been so comfortable. By the beginning of the 20th century, China was ripe for fundamental change.

With its commitment to modernization and technological development, the People's Republic of China (PRC) could be viewed as the culmination in the transformation of Chinese culture, a process that began with the opium wars. This would be an oversimplification, for even today it is premature to conclude that modernization through the balancing of imported technologies with indigenous Chinese culture has been achieved. If anything, the problem is now even more acute, for cultural patterns in today's China are compounded of ancient tradition and modern socialist doctrine, and tensions between technological development and ideological patterns—both ancient and contemporary—persist.

Technology has not acted as an independent force which has autonomously transformed the traditional culture and shaped the postrevolutionary society. In traditional China, patterns of political and cultural domination in large measure determined the nature and extent of technological change. This is still the case, as the Communist government has manifestly committed itself to generating the policies that will guide the process of technological development. Yet it has never had a free hand in this matter; the possibilities of technological advance have been circumscribed by both the characteristics of Chinese society and the other goals of the leadership. The next section considers the evolution of technological policies in the PRC and the limitations on their implementation. Although the political actors and many of the fundamental goals are different from those of traditional China, technological change has remained firmly in a Chinese context.

POSTREVOLUTIONARY TECHNOLOGY POLICY

Although many changes have come to the PRC over the last three decades, there remains a certain continuity of goals and activities. Any analysis of technological policy must be cognizant of continuity as well as change. Most analyses of policy in China have given relatively little consideration to continuity; instead, most Western scholars have focused their attention on the apparently wide fluctuations in basic policies as the PRC has oscillated between periods of radical change and periods of retrenchment. From this perspective, "Maoist" methods of employing mass mobilization, popular initiative, and ideological incentives have been counteracted in succeeding phases by policies that were built around expertise, precise organization, and remunerative rewards. Although this characterization of social change in China has put policy changes in context, the policy cycle model can be taken as only a rough approximation of historical reality. Despite apparent shifts of considerable magnitude, there has remained a basic continuity of goals in China and a narrowing range of policies has been employed as a means of achieving these goals. '" Moreover, in any given period, there are considerable divergencies between the specific policies employed in different economic and political realms (such as agriculture, education, and foreign relations). Even technological policy is itself too broad an analytic category to be easily fit into a broadly drawn policy cycle model; at any time, technological policy is really a cluster of separate policies which reflect the differential impact of general policies on specific sectors of the economy .11 Finally, the chronology of policy changes in China is not an unending series of back and forth movements along a single axis; the history of the PRC has been a learning experience for the

'{'See Andrew Nathan, "Policy Oscillations in the People's Republic of China: A Critique, " *China Quarterly 68* (December 1976).

' 'See Alexander Eckstein, *China's Economic Revolution* (Cambridge, Mass.: Cambridge University Press, 1977), p. 85.

Chinese people and the leadership alike. Neither a "Maoist" nor a "pragmatic" model of development is likely to be taken as an inclusive blueprint for social change and economic progress, and the years to come will likely see continued efforts to produce a workable resolution of the conflicts between egalitarian participation and managerial direction, mass motivation and professional expertise, and ideological incentives and monetary rewards.

When the Communists gained control over the Chinese mainland in 1949, these dilemmas were faint concerns. After years of foreign invasion and civil war, China was in desperate need of economic reconstruction. Providing a modicum of economic organization and meeting the minimal subsistence needs of a war-ravaged populace were in themselves staggering tasks. In addition, the Communists had set a more ambitious task—the transformation of a backward and easily exploited country into a strong and self-sufficient Socialist nation.

Technological development was to be an integral part of this transformation. In addition to restructuring economic institutions and relationships through land reform, the nationalization of key industries, and the construction of a central-planning apparatus, the new Government began to take the first steps toward the formidable task of modernization of production. Despite some promising starts in industrial development during the 1930's,[12] China had scarcely risen above the agriculture-and-handicrafts economy which had endured for centuries. To build a foundation for China's economic modernization, 156 large industrial projects were designed and built with the direct assistance of the Soviet Union. China's isolation from the capitalist world made Soviet assistance crucial, and the U.S.S.R. responded with one of the largest programs of economic aid and technology transfer in history.

It can be argued that the pattern of economic development that emerged under Soviet sponsorship was in fact ill-suited to China's developmental needs. The Chinese embarked on an essentially Stalinist strategy which emphasized the rapid development of heavy industry through the construction of the large industrial projects under Soviet patronage. At this time, the Government plowed 20 to 25 percent of the country's total output into investment, a percentage similar to the Soviet Union and other Communist countries during the first years of their existence.[14] This investment was confined to a narrow part of the economy; in 1952, industry received nearly 40 percent of investment funds, and heavy industry was allocated 76 percent of this.[15]

The distribution of investment funds was reflected in the choice of technologies. Few efforts were made to develop and apply technologies that could make use of China's abundant labor supply or be tied into the agricultural economy. The Chinese received state-of-the-art technologies from the Soviets, particularly in the area of steelmaking,[16] but modernity in the emerging industrial sector underscored the continued backwardness of farm technologies. In the agricultural sector investment rates remained astonishingly low. Less than 8 percent of the State budget was invested in agriculture during the first 5-year plan (1953-57), and of this, a sizable percentage went toward the construction of hydraulic projects only margin-

[12] See John K. Chang, *Industrial Development in Pre-Communist China: A Quantitative Analysis* (Chicago, Ill.: Aldine, 1969).

[13] Robert Dernberger, "Economic Development and Modernization in China," in Frederic Fleron, ed., *Technology and Communist Culture: The Socio-Cultural Impact of Technology Under Socialism* (New York and London: Praeger, 1977), p. 250.

[14] K. C. Yeh, "Soviet and Communist Chinese Industrialization Strategies," in Donald W. Treadgold, ed., *Soviet and Chinese Communism: Similarities and Differences* (Seattle and London: University of Washington Press, 1967), p. 339.

[15] Jan S. Prybyla, *The Political Economy of Communist China* (Scranton, Pa: International Textbook Company, 1970), p. 56.

[16] M. Gardner Clark, *The Development of China's Steel Industry and Soviet Technical Aid* (Ithaca, N.Y.: Cornell University Press, 1973), p. 6.

ally connected to the needs of farm production.

Technological change would have to come to the countryside if the perennial problem of feeding China's people was ever to be solved. But this realization was slow in coming, and stipulated technological priorities bore little relevance to agricultural needs. In September 1956, a 12-year plan for the development of science and technology was formulated. Although the details of the plan were never released, 12 areas earmarked for future technological advance were published:

1. peaceful uses of atomic energy,
2. radio and electronics,
3. jet propulsion,
4. automation and remote control,
5. petroleum and scarce mineral exploration,
6. metallurgy,
7. fuel technology,
8. power equipment and heavy machinery,
9. the harnessing of the Yellow and Yangtze Rivers,
10. chemical fertilizer and the mechanization of agriculture,
11. prevention and eradication of diseases, and
12. problems of basic theory in natural science. *[8]

As the list indicates, the main thrust of scientific and technological research and application was to be directed at the development of technologies essential to the operation of a sophisticated modern economy. With the exception of items 9 and 10, none of the areas selected for intensive development had any immediate relationship to the needs of the agricultural economy, nor were they congruent with the development of labor-intensive modes of production. In sum, ambitions seemed to have exceeded economic and political realities; after decades of submission and inferiority, China was determined to catch up with the scientific and technological accomplishments of the West.

The limitations of the Chinese economy soon overwhelmed these ambitions. Although industrial growth during the 5-year plan period was impressive, the agricultural sector continued to lag. Collectivization and other administrative rearrangements had not resulted in an increase of peasant income[19] and by 1957 Chinese agriculture was in the hold of diminishing returns as the farm sector began to exhaust its traditional sources of growth. Although industrial development was impressive, it was apparent that future economic progress in that sector was tied to economic progress in agriculture.

Improved agricultural productivity was of foremost importance in the economic development of the countryside, but at first the Government sought to generate it in an oblique fashion, using political mobilization as a means of coaxing out the "productive forces" which had hitherto lain dormant. The Government accurately gauged that a technological revolution in crop growing was ultimately dependent on the widespread development of water-control projects. In order to effect the necessary changes in irrigation, the Communist leadership began to make massive efforts to tap China's seemingly limitless supply of rural labor for the building of dams, canals, wells, and reservoirs. During the slack farming season in the winter of 1957-58, 100 million people worked an average of 130 days each on hydraulic projects of this kind. '() It was hoped that the construction of these projects would make a

[17] Li Choh-ming, *Economic Development of Communist China: An Appraisal of Five Years of Industrialization* (Berkeley, Calif.: University of California Press, 1959), p. 53.

[18] Richard P. Suttmeier, *Research and Revolution: Science Policy and Societal Change in China* (Lexington, Mass.: Lexington Books, 19'74), pp. 60-1.

[19] Thomas P. Berstein, "leadership and Mass Mobilization in the Soviet and Chinese Collectivization Campaigns of 1929-30 and 1955-56: A Comparison," *China Quarterly* 31 (July-September 1967), p. 35.

[20] Karl A. Wittfogel, "U.S.S.R. and Mainland China: Agrarian Systems, " in W .A, Douglas Jackson, cd., *Agrarian Policies and Problems in Communist and Non-Communist Countries* (Seattle and London: University of Washington press, 1971), p. 46. Alva Lewis Erisman presents a much lower figure of nine million man days: cf. "China: Agricultural Development, 1949-71,'" in *People's Republic of China: An Economic Assessment* (Washington, D. C.: U.S. (government Printing Office, 1 972), p, 1 26. In any event, statistical ambiguity was a hallmark of the Leap.

major contribution to the Great Leap Forward, which sought to transform China's economy in the space of a few years.

So massive a mobilization of rural labor had to be complemented by fundamental changes in the organization of rural society. At first, special water conservancy organizations were formed. These and other forms of cooperatives were used to deploy peasant labor for projects that exceeded the boundaries of the village. Eventually most of these units were amalgamated into people's communes. In the summer of 1958, the communes began to proliferate, and by the end of the year 99.1 percent of the peasant households were reportedly incorporated into them.

The establishment of the communes was paralleled by a major effort to decentralize political authority and administration. Initiative in economic and technological matters was passed to lower administrative levels. Industry, agriculture, commerce, education, and defense became the concerns of commune administrators, thus vastly expanding the responsibilities of local cadres.

This expanded role for local-level leadership had important ramifications for technological policies and their implementation. Party cadres began to assume many of the technical and managerial tasks previously held by Government officials." This did not simply mean the imposition of political control over the activities of technical and managerial personnel; political cadres, it was hoped, would become experts in their own right, the cadres' personal involvement with productive labor would result in the synthesis of "red" and "expert."[22] The transfer of political cadres to basic-level posts, where they could participate in labor while overseeing day-to-day operations, was a key policy of the Great Leap Forward.

First-hand involvement with local economic affairs was an absolute necessity; with the radical decentralization measures of the Great Leap Forward, the formal national planning apparatus and the statistical work that supported it were dismantled. The detached and rationalized style appropriate to administration by Government officials and specialized experts was forsaken in favor of a "combat style" through which leaders were to form an intimate association with the people, share in their struggles, and make policy on a largely *ad hoc* basis.[23] The Great Leap Forward was a time of politically mandated uncertainty and disjointed or nonexistent planning.

The technological consequences of the Great Leap Forward were soon evident. The 12-year plan for the development of science and technology was all but forgotten as uncoordinated local initiatives became the basis of technological change. Each locality began to push its own programs of economic and technological development through the communes. Although great emphasis continued to be placed on the rapid development of the heavy industrial sector in the cities, the countryside now became the scene of myriad labor-intensive projects. In the cities, heavy industry continued to be the primary recipient of State-supplied capital and technical assistance; in the countryside productive enterprises were to be developed through the mobilization of local labor and resources. The urban enterprises established during the 5-year plan period would continue to grow through the conscious fostering of economic dualism, while new small-scale, labor-intensive ones took root in the countryside. There were few connections between the two sectors.[24]

The most dramatic example of local initiative in technological and economic develop-

[21] Franz Schurmann, *Ideology and Organization in Communist China* (Berkeley and Los Angeles, Calif.: University of California Press, 1968), p. 171.

[22] New China News Agency, "CCP CC Directive on Physical Labor" in *Survey of China Mainland Press*, No. 1532.

[23] 'Such a mode of leadership is often found among circumstances of danger and uncertainty. See Alvin W'. Gouldner, *Patterns of Industrial Bureaucracy* (New York: Free Press, 195'7), pp. 105-16.

[24] Eckstein, op. cit., p. 57.

ment were the "backyard blast furnaces" which were erected for the local production of steel. Coinciding with the commune movement in the summer of 1958, thousands of furnaces sprung up each day in the countryside; by September, 350,000 were in operation." This effort was a sad failure: the steel produced was of such low quality that it had few applications. Other efforts at decentralizing production were more successful, however, and the foundation of local industries for the production of cement, agricultural chemicals, and energy was laid during this period. Meanwhile, the urban industrial sector continued to emphasize capital-intensive higher technology methods of production.

In the critical agricultural sector, however, the policies embodied in the Great Leap failed. A key assumption–that mobilized labor could be effectively tapped without complementary inputs—soon proved fallacious. Agriculture continued to languish in the absence of modern inputs and techniques, and China found itself in the grips of a severe economic crisis. This was exacerbated in the middle of 1960 when the Sino-Soviet rift widened and Soviet economic and technical support missions were withdrawn.

The Chinese leadership now had little choice but to retrench, and mass mobilization under the leadership of technically unsophisticated political cadres was abandoned as the most appropriate road to economic progress, A decentralized economic system with strong inputs from technical experts once again took precedence over efforts to create an autarkic rural economy through collective labor and political leadership.

Although the policies of the Great Leap Forward had been specifically constructed to provide an improved productive base in the countryside, the rural economy remained critically deficient in both the kind of technologies employed and the capital investment necessary for their application.

In 1962, the critical importance of the farm sector was officially recognized and a slogan declaring agriculture the "foundation" of the economy was adopted. Industrial production was more closely tied to agricultural needs, and the central Government began importing complete plans from Japan and Western Europe for fertilizer manufacture. At the same time, the rural sector was better enabled to make effective use of these inputs. Agricultural taxes were eased and the price relationships between industrial and agricultural goods altered in favor of the latter, thereby increasing the incentives for increasing crop production.[26]

Industrial policy now shifted, and a more rationalized and coordinated approach to increasing production was taken, stressing technological innovation over untrammeled mobilization of labor. The responsibilities and authority of managers and technicians were expanded. The political cadres who had supervised local production and technological innovation were replaced by engineers and managers with the specialized skills necessary for modernizing China's economy.

Yet engineers still did not have a free hand to design projects according to the standards of technical competence alone. Efforts to synthesize mass participation in technological development with the more regularized procedures of engineers, scientists, and technical specialists continued. During the design reform campaign which began in late 1964, engineers became more closely involved with actual production work. They were expected to break away from accepted engineering traditions, established during the period of Soviet influence, to engage in on-the-spot design work in close collaboration with the workers and managers in the plant. This was expected to result in a combination of technical experts, managers, and shop-floor workers who could pool their talents in order to solve technical problems.[27]

[25] Clark, op. cit., p. 69.

[26] Eckstein, op. cit., p. 60.

[27] See Genevieve Dean, "A Note on the Sources of Technological Innovation in the People's Republic of China," *Journal of Development Studies* 9, 1, (October 1972), pp. 190-193.

Despite this effort to unite all segments of the Chinese work force, tensions remained, and Mao and his followers feared that the extension of expertise and administrative power would result in the formation of new social classes and new sources of oppression. In late 1965, Mao launched the Great Proletarian Cultural Revolution as a means of redressing the inequalities reemerging in Chinese society. Although the cultural revolution did not take up the issue of technological policy directly, it did have important repercussions on the people and institutions directly responsible for promoting technological development. The Chinese Academy of Sciences came under heavy criticism from "Mao Zedong Thought Propaganda Teams, " which had been organized by the army under the guidance of Lin Biao. The State Scientific and Technological Commission fared even worse. Its Chairman Nie Rong-Zhen was sharply attacked, and for a while the Commission was threatened with dissolution; an *ad hoc* Science and Education Group under the State Council seemed likely to assume its functions.[28]

For all the strident attacks on the entrenched centers of technological expertise, however, political control over technological change was not a prime issue during the course of the cultural revolution. The chief struggles of the period were directed at political (rather than technical) cadres who, it was claimed, had become entrenched in their offices, separated themselves from the masses, and forgot their revolutionary roots.

The convening of the Ninth Party Congress in April 1969, signaled an official end to the militant phase of the cultural revolution. The ensuing period was marked by conflicting political signals and uncertainty in technological policy. Imports of machinery and whole plants began to increase dramatically by 1973,[29] hardly a hallmark of the success of the radicals' efforts to insulate China from foreign influences. The fundamental changes that the cultural revolution wrought in education and research activities generated considerable discontent, including complaints about the excessively practical orientation of research efforts and the absence of adequate basic research. In 1972, the Chinese press featured articles calling for the improvement of science curricula and for more attention to the conduct of theoretical research.[30]

On the other hand, the cultural revolution left an inhibiting policital legacy. Although technological policy was never publicly debated, the postcultural revolution climate was not conducive to bold new thrusts in the technological realm. Ideological rectitude seemed to count more than economic expansion, and with Mao's succession very much in doubt, few leaders were willing to challenge basic Maoist tenets about the primacy of political and ideological mobilization.

This impasse was seemingly broken in January 1975, when Chou En-lai delivered an important speech at the Fourth National People's Congress. In it, he asserted that China's prime task lay in the "four modernizations" (in agriculture, industry, defense, and science and technology). These would pave the way for China's sustained development as a "powerful socialist nation' by the beginning of the next century .3'

Chou's assessment of the pressing need for technological modernization was seconded by Deng Xiaoping, who had reemerged from his cultural revolution disgrace. Deng used his newly regained influence to aggressively push for technological modernization, even at the expense of class struggle and party domination over technical work. But with Mao's health steadily weakening and China's political course in doubt, Deng was made the target of continual attacks in the Chinese press. He was

[28] Suttmeier, op. cit., pp. 104-5.

[29] See Hans Heymann, Jr., *China's Approach to Technology Acquisition: Part 111, Summary Observations* (Santa Monica, Calif.: The RAND Corporation, 1975), p. 7.

[30] See Thomas Fingar and Genevieve Dean, *Developments in PRC Science and Technology, October-December, 1976* (Stanford, Calif.: U.S.-China Relations Program, 1977), p 5.

[31] Chou En-lai, *Cheng-fu Kung-tso Pao-h'ao* (Report on the Work of the Government) (Peking: Shen-wu Yin-shu Kuan, 1975), p. 16.

again purged in April 1976, and his report, which called for an expanded and more autonomous role for the Academy of Sciences, was labeled a "poisonous weed."[32] Deng's alleged enthusiasm for importing advanced technologies from abroad in return for raw material exports,[33] was also criticized. This policy was in direct opposition to the autarkic economy advocated by his Maoist opponents.

)'Thomas Fingar and Genevieve Dean, *Developments in PRC Science and Technology, January-March 1977* (Stanford, Calif.: U.S.-China Relations Program, 1977), pp. 5-7.

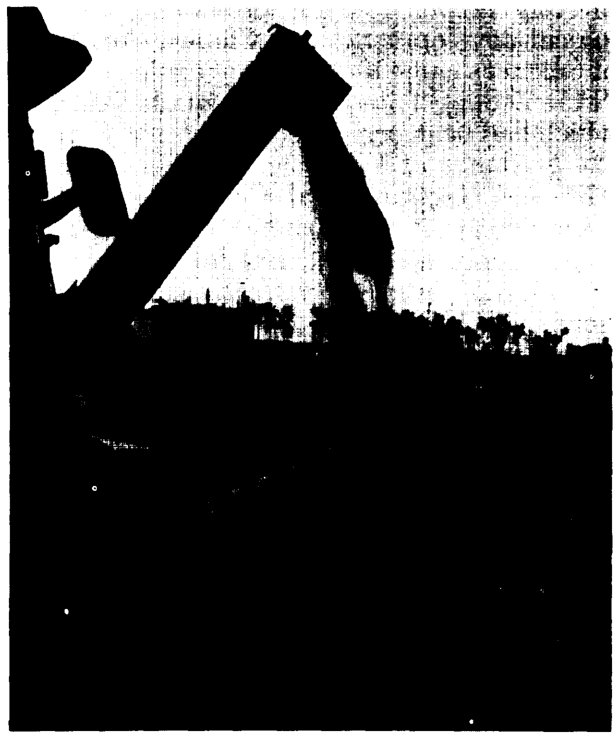
[33] See Hung Yuan, "Ultra-Right Essence of Teng Hsi p'ing's Revisionist Line, " *Hung Ch'i* 10, (1976), in *Foreign Broadcast Information Service,* Oct. *8, 1976,* p. E 1.

PRESENT TECHNOLOGY ACQUISITION POLICY

Mao Zedong died in 1976; by the beginning of 1977, it was clear that a return to the principles of the four modernizations could be anticipated. Indeed, throughout 1977 there were abundant signs of departure from many of the practices and policies of the previous 10 years. In February 1978, a statement of the goals of the four modernizations program was made by Premier Hua Guofeng in his "Report on the Work of the Government" delivered to the first session of the Fifth National People's Congress. Hua's report contained the outlines of an ambitious 10-year economic development plan designed to produce an independent and comprehensive national industrial and economic system.

Among other things, this plan provided for enormous increases in agricultural output; agroscientific research; increases in the value of industrial output of 10 percent per year to 1985; the development of transport, communications, postal, and telecommunications networks big enough to meet growing industrial and agricultural needs; and 120 large-scale industrial projects. It was followed by plans for investment in science and technology including theoretical research and the establishment of nuclear power stations, the development of satellites, laser research, genetic engineering, and integrated circuit and computer applications.

To foreign observers, this program was exceedingly ambitious and it seemed to lack a sense of priorities. Doubts within China



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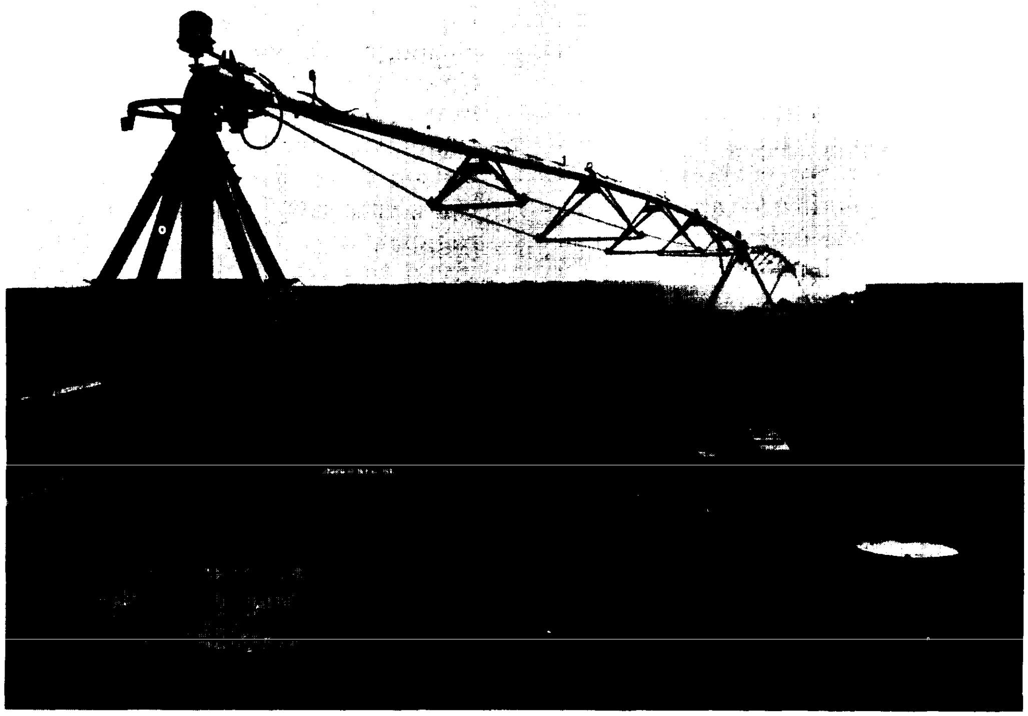


A U.S.-made sprayer at work

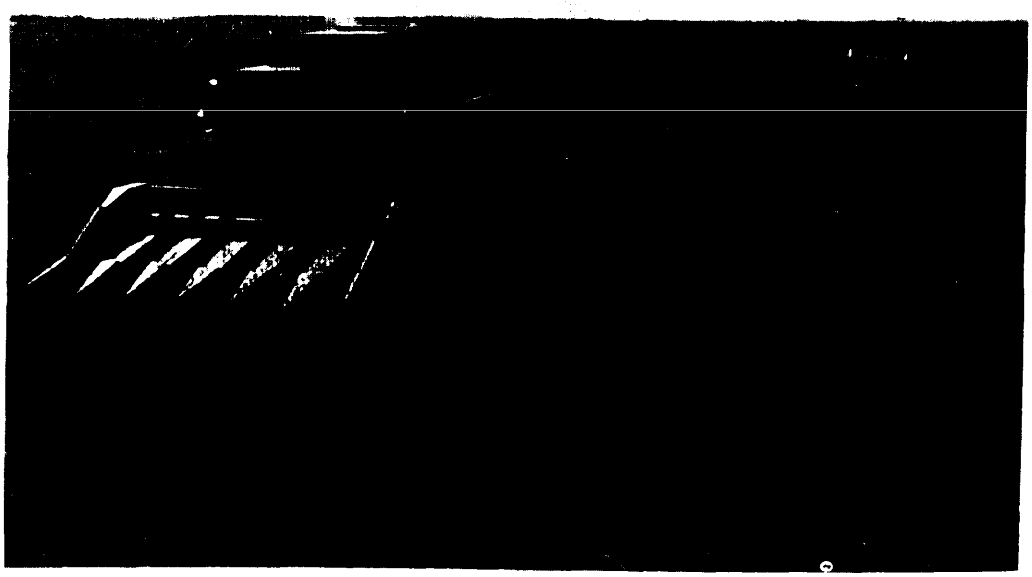


Photo credits Ben Lanwu Xinhua News Agency

Combine harvesters working in a soybean field of the Friendship Farm

In redefining the objectives of the four modernizations, Beijing has begun to stress the concepts of "balance" and "proportionate development, " and the thinking associated with the economic administration characteristic of the 1950's is now being praised. "Three major balances, " have been identified as the foundation for economic policy: the balance in the expenditures and revenues of the State budget; the balance in the issuance and withdrawal of bank credits; and the balance in the supply and demand of materials, including the balance of receipts and payments of foreign exchange. It is claimed that during the last 30 years, when these balances were observed, the economy progressed nicely; when they were not observed, development slowed. According to this line of reasoning, serious imbalances have now occurred between development in agriculture and industry, particularly heavy industry; within industry itself (for instance, between the fuel, power, and raw materials industries and the processing industries; among farming, forestry, and animal husbandry; and between food crops and industrial crops); between investments and capital construction and the availability of manpower, materials and financial resources; between accumulation and consumption; and within accumulation itself (e.g., between accumulation for productive purposes and accumulation for nonproductive purposes) .34

It is safe to assume that fears of new "imbalances" are behind the current efforts to scale down the four modernizations, and that balance and proportion in development are the objectives now being sought. This conclusion is borne out by the main points of the revised program which is intended to check the spurt of investments in heavy industry, and return to the principle of priority for agriculture and light industry. There have been reports that the proportion of investment in iron and steel will be reduced: past investments have not yielded expected returns because of serious shortages of electricity, transport, and other necessary supporting infrastructure. Major investments in harbor construction are to be postponed. Agriculture is to receive the most attention, although the grand objectives for agricultural mechanization announced in early 1978 have been abandoned. Instead, it is likely that investment will foster greater differentiation of agricultural production based on the comparative characteristics of different regions, and that more attention will be given to cash crops and to industries supporting agriculture. The performance of Chinese agriculture is of utmost importance to the four modernizations; successful performance in this sector would release foreign exchange for other purposes.

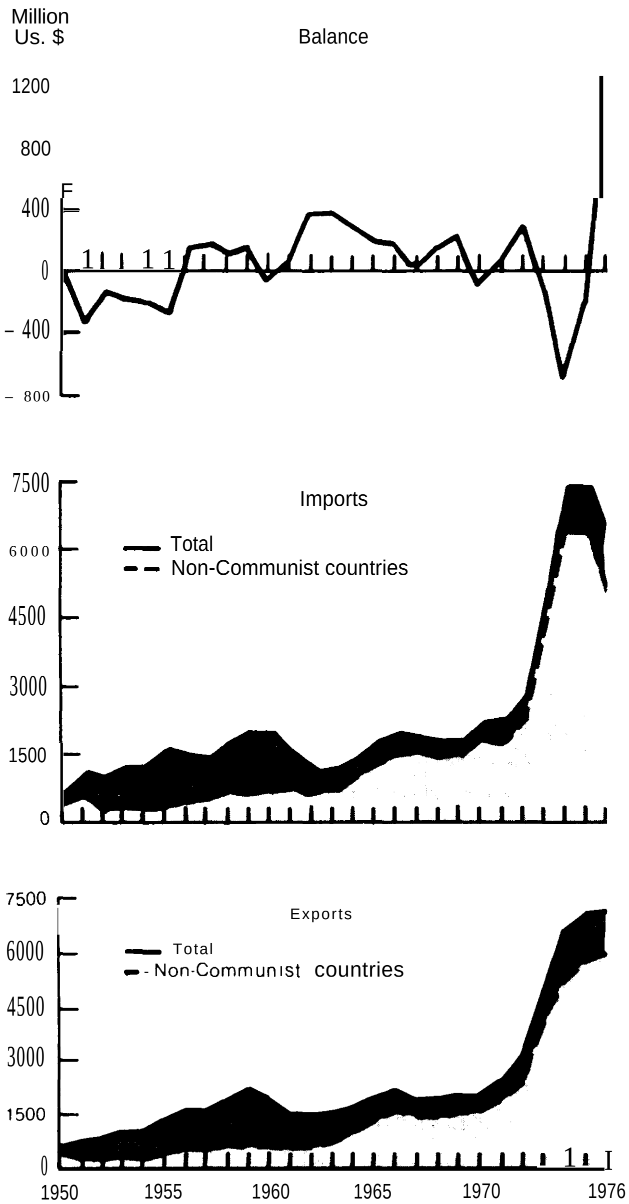
The serious problems of Chinese infrastructure development will be addressed by additional investments in coal, electric power, oil, transport, and building materials. Some of the 120 key industrial projects identified in the original four modernizations program will be postponed, and only a limited number will be in operation by 1985. Housing construction is to be accelerated. New attention also is to be given to light industry, both to satisfy domestic aspirations, and to make light industry the chief export and foreign exchange earner over the short run. Although foreign borrowing has not been completely ruled out, the Chinese are stressing that future investments should come mainly from domestic savings.

In spite of these cutbacks, it is clear that foreign trade and the acquisition of foreign technology will play an important role in Chinese modernization programs, although not as great a role as the euphoric estimates of 1978 might have suggested. China's foreign trade has fluctuated somewhat over time, but it has tended to rise consistently through the 1970's. Figure 15 shows the Chinese balance of trade from 1950 to 1976, including the shares of trade that non-Communist countries have enjoyed since the early 1960's.

In addition to agreements with individual foreign companies, China has entered into trade agreements during the last 2 years

"*Beijing Review*, May 11, 1979, pp. 17-18.

Figure 15.— China: Balance of Trade, 1950-76



SOURCE Richard E. Batsavage and John L. Davie, "China International Trade and Finance, in Chinese Economy Post Mao, Joint Economic Committee, 1978. p. 709

with a number of countries. The most dramatic example is a $20 billion agreement with Japan calling for Chinese imports of technology in exchange for oil and coal. These agreements indicate that at least through 1985 China will continue to have an active interest in foreign trade and particularly in foreign technology. A recent estimate of China's budget for imports of foreign technology through 1985 shows that $11.4 billion was contracted for in 1978, and that negotiations to acquire additional technology could amount to as much as $59 billion by 1985. China's foreign technology budget is summarized in table 40.

While revisions in the four modernization programs may lead to a scaling down of Chinese foreign technology purchases, there will undoubtedly be major acquisitions in the next 5 to 8 years. According to a recent Central Intelligence Agency (CIA) report, the areas that China has designated for closest attention are as follows:

1. Iron and Steel.—It is expected that this sector will require the greatest expenditure of foreign exchange. The plans for doubling China's steel pro-

Table 40.—China's Foreign Technology Budget, 1978-85
(in billions of dollars)

Category	Contracted for in 1978a	Under negotiatin[b] (rounded estimates)
Iron and steel	$ 0.1	$19.0
Coal	4.0	1.6
Other mining and processing	2.4	4.4
Ports	2.1	11
Petrochemical plants and equipment	0.5	23
Hotels	0.5	3.0
Shipping	0.5	—
Petroleum	0.4	3-5
Electronics	0.3	0.1
Agriculture-related plants and equipment	0.1	0.6
Power development	0,2	3.0
Fisheries	—	2.0
Aircraft	–	10
Other transportation	—	10-15
Construction plants and equipment	0.2	05
Textile plants and equipment	—	0.1
Miscellaneous machinery and machine tools	0.1	**0.2**
Total	$11.4	**$52-59**

Data as of Apr. 15, 1979
[a]Excludes approximately $15 billion in projects contracted after mid-December 1978 which were postponed until financing is arranged
bSome projects under negotiation will be completed after 1985

SOURCE The *China Business Review,* March-Aprll 1979 p 57 duction to 60 million tons by 1985 can only be achieved by importing major new steel complexes. Contracts under discussion have included a $15 billion, 10-million ton complex near Tianjin in Hubei Province, and a $2 billion major facility at Baoshan near Shanghai. The latter was to be a complete plant purchased from Japan, a deal which has now been delayed but not canceled.

2. Coal and Electric Power.–China's original plan called for the opening of 8 new major coal mines and 30 power stations by 1985. A coal industry development project worth $4 billion has been under discussion with West Germany. Discussions have been held with France for the construction of two nuclear powerplants, but no contracts have resulted. Priority in electric power development will probably go to conventional sources of power, including major new hydroelectric stations.

3. Transportation.—This has been a hitherto neglected area, and Beijing has been moving aggressively toward reversing this situation. Reportedly, since 1976 more than $1 billion has been set aside for foreign equipment in road, rail, water, and pipeline transportation, and negotiations valued at $4 billion have been conducted for imports of truck, automobile, railroad car, and locomotive plants and for shipping facilities.

4. Petrochemicals and Synthetic Fibers. —Approximately $3 billion in contracts for technology in petrochemical and synthetics fields have been signed.

5. Communications and Electronics.— This is another sector that has been neglected in the past but which now has a high priority. China evidently wishes to leapfrog toward the most modern communications systems and has entered into discussions with the United States for a communications satellite. It has also concluded an agreement with Japan for manufacturing facilities for color television sets. Part of this deal included the purchase of an integrated circuit plant.

6. Nonferrous Metals.–Signed agreements exist in this area with Japan and the United States for a copper mining concentration complex and a copper smelter. Of the 120 key projections in Hua's original formulation of the 4 modernizations, 9 dealt with nonferrous metals complexes.

7 Construction.—China's construction industry has also been somewhat neglected in the past and has become a major bottleneck for the expansion of other sectors that require massive construction programs. As a result, China has been interested in cement, asbestos plate, insulation, and construction equipment. These have a projected value of about three-fourths of a billion dollars.

8. Petroleum and Gas.–Both because of domestic energy shortages and because of the potential of this sector as a foreign exchange earner, the petroleum and gas industry has received high priority. Since 1976, $500 million has been spent on oil and gas exploration and exploitation equipment.

9. Machine Building.—China is interested in foreign forges, foundries, press lines, and cutting tools which could lead to whole plant contracts totaling more than $70 million.

10. Instruments and Controls.—China's economic leaders have, in the last few years, shown a renewed interest in quality control and standardization of products. As a result there has been considerable interest in measuring instruments and analytic devices, and control mechanisms for quality control.

11. Agriculture.—Thus far, a relatively small amount of agricultural machinery has been purchased, primarily for

use in the large-scale State farms in the north. With the reduction of mechanization goals in the revised version of the four modernizations program, machinery imports in this sector could be less than originally anticipated. On the other hand, China will probably continue to be interested in turnkey projects for fertilizers and insecticides.[35]

[35]Central Intelligence Agency, *China: Post-Mao Search for Civilian Industrial Technology*, National Foreign Assessment Center, 19'79, pp. 4-6.

In addition, China has shown considerable interest in engineering and service contracts intended to supply design-engineering know-how and managerial skills. Such contracts provide for foreign firms to design, act as prime contractor, and supervise the development of various projects. The transportation and mining sectors have received the most attention: contracts have been signed with West Germany and the United Kingdom for coal mine development, and a major service contract for railroad development has been under discussion with Japan. Negotiations have also been conducted with Denmark on port construction.

THE NATURE OF THE CHINESE ECONOMY

When the PRC was established, Chinese leaders looked to the Soviet Union for guidance and to the Soviet economy as a model to emulate. Although this close relationship lasted only until 1956, the Chinese and Soviet economies still resemble each other. Both are characterized by central planning, and both tend to focus on physical output as a criterion for evaluating performance. This has resulted in less attention to the value of production efficiency.

While there are similarities in the two economies there are also significant differences, The Chinese economy is both more decentralized and far more ideologically driven than the Soviet. As a consequence, China has had a looser approach to economic planning than has the U. S. S. R., and at times ideologically induced decisions have superseded planner preferences. Decentralization stems from 1956 to 1957, when dissatisfaction with the Soviet model began to surface. As previously noted, the first significant decentralization occurred as part of the Great Leap Forward in 1958, when a wide range of industries and financial resources were placed under provincial control and Communist Party committees at the province and subprovincial levels were assigned a more direct role in running economic activities.

This had many negative results and was modified during the early 1960's. It is the second model of decentralization which largely persists today. The significant differences from the Great Leap model are first, that professional managers and engineers share responsibility with Party committees in the leadership of enterprises; and second, that responsibility for finance and commerce is held closely by the central Government in contrast to the Great Leap years when this responsibility was relinquished. It should be noted that China's search for a balance between centralized and decentralized forms of economic management is closely related to the search for a balance between economic efficiency (which has tended to lead to decentralization) and the distribution of wealth and economic equity (which has tended to support the continuation of an active central role in interprovincial redistributive revenue-sharing).[36]

There have also been attempts to accommodate the power interests of influential provincial leaders. It is possible to think of the Chinese industrial economy as a three-

[36]Nicholas R. Lardy, *Economic Growth and Distribution in China* (Cambridge, Mass.: Cambridge University Press, 1978)

tiered phenomenon, the three tiers being "center," "local," and "collective." Although the collective sector is subject to planning, it experiences a measure of autonomy not enjoyed by the other two tiers because it is entitled to use aftertax profits in a locally discretionary fashion. Establishing and upgrading rural industry have been important investment options for the collective sector.

The "local" sector includes enterprises under provincial, municipal, and county control. Unlike those in the collective sector, these enterprises are all under State ownership, and, despite the nomenclature, are subject to a significant amount of central influence. Local sector output forms a substantial part of the total value of Chinese industrial output.

Despite considerable decentralization, the central Government continues to be important. It maintains control over much heavy and strategic industry; it acts as the allocator of such priority goods as energy, key raw materials, capital goods, military equipment, important exports, staple food products, and cotton; and it controls interprovincial trade.[37] The center maintains control over the economy through such mechanisms as material supply planning; the fiscal and banking systems; and control over prices, wages, and foreign trade.[38]

According to a recent statement by the State Planning Commission (SPC), the center's responsibilities include:

> 1. the guidelines and policies of the national economy; 2. output targets for major industrial and agricultural products; 3. basic construction investment and major construction projects; 4. allocation of important materials; 5. the purchase and allocation of key commodities; 6. the state budget and the issuance of currency; 7. the number of workers and employees to be added and the total wage bill; 8. the prices of major industrial and agricultural products .39

SPC plays a key role in the planning system of the Chinese economy. It is generally believed that the preparation of economic plans involves both vertical or functional planning, and horizontal or territorial planning.[40] This dual approach is consistent with the concept of dual control over the economy in which enterprises are subject both to central ministries and a unit of local government. At the central level there are a large number of economic ministries that oversee the operation of the economy. These are organized along functional lines. Enterprises throughout the country that have the same functional identification come under their jurisdiction. One stream of planning activity apparently occurs in this vertical system.

On the other hand, there is a second stream of planning activity that is territorial, centered around the province. Planning is a process of aggregation and disaggregation of data and tasks. Whereas in the vertical stream the aggregation and disaggregation is performed by ministries and subordinate enterprises, in the territorial stream this is done by provinces and by the enterprises within provincial boundaries. It is the responsibility of SPC to aggregate on a national basis the information produced in these two streams of activity.

The planning process is thought to involve three main stages which the Chinese refer to as "sent down twice, reported up once."[41] The process begins when SPC issues "control numbers" for the coming year. These include value of output, amount of investment, number of workers, and total wage bill and are determined on functional and territorial bases. These flow down through the system, territorially and functionally, generating more specific planning information which is

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[37] Gordon Bennett, *China's Finance and Trade* (M.E. Sharpe, 1978), p. 74.

[38] Lardy, op. cit., pp. 15-16.

[39] Quoted in Nai-Ruenn Chen, "Economic Modernization in Post-Mao China; Policies, Problems, and Prospects, " in Joint Economic Committee, *Chinese Economy Post-Mao* (Washington, D. C.: U.S. Government Printing Office, 1978).

[40] Lardy, op. cit., pp. 15-16.

[41] Ibid.

"reported up" and eventually gets back to SPC. This upward and downward flow of information is by no means a purely technical operation; it is highly political, characterized by bargaining and tradeoffs, and probably resembles the U.S. budget process. After the "reporting up once" stage, SPC aggregates the information and produces a final plan for the economy.

Provisions for innovation, presumably also including the incorporation of foreign technology, are folded into the plans during this process. But as with the Soviet economy, significant structural constraints on innovation are related to the system of management. China has seen a variety of approaches to enterprise management since the 1950's; it has been the subject of political dispute and ideological debate, centering around the problem of whether "reds" or "experts should run factories. Additional issues have concerned whether production norms should predominate in management, and the use of material incentives, Managerial systems have varied from the Soviet style "one man management" to management by Party committee. Since 1978, the role and authority of professional managers and expert engineers has been emphasized, although the Party still has final responsibility and many, if not most, managers are members of Party committees.

Regardless of managerial form, it is important to note the criteria used by higher authorities to evaluate management, and the performance of firms in fulfilling the objectives of the plans. Performance criteria have changed over 30 years, but there have always been multiple, sometimes contradictory, criteria. For example, a 1972 report lists performance criteria as quantity, quality, variety, cost relationship, labor productivity, profits, and funding; plus numbers of workers and total wage bill.[42] The targets were output, variety, quality, consumption of raw materials, fuel and power, labor productivity, costs, profits, and working capital ratio.[43]

While enterprises are expected to meet all of these targets, from time to time there has been a tendency for enterprises to focus only on physical output in the belief that the planning system is biased in this direction. Attention to this target has led to losses in efficiency, product quality, and innovation:

> Innovation is another frequent casualty of the drive to raise output. Research and experimentation require the attention of engineers and skilled workers whose services are also needed to maintain high levels of output. Complaints that "many enterprise leaders who are very concerned about plan fulfillment pay little attention to new product work" fall on deaf ears as long as quantity rules supreme. Conflict between research and production persists. In 1971, at Shanghai's Hung Ch'i shipyard, "Under the condition of the urgency of the task of production, there were some people including some members of the basic level revolutionary committee who said, 'the task of production is already so heavy, where is there time for carrying out innovation?' There are even some who said, 'The task of production is a hard target, but the task of scientific research is a soft target. "4[4]

Although there are signs that in some respects, particularly in terms of intersectoral communication, the Chinese economy is more innovative than the Soviet economy, it nevertheless imposes technically conservative norms on enterprise managers. In the Soviet case, this has inhibited not only indigenous innovation, but also the effective absorption of foreign technology .4' (See chapter X.)

As discussed above, one of the central Government's reactions to the chaos of the Great Leap Forward was to reassert tight financial control over the economy. This con-

[42]See Thomas G. Rawski, "China's Industrial System," in Joint Economic Committee, *China: A Reassessment of the Economy*, 1975.

[43]Chen, op. cit.

[44]Rawski, op. cit., p. 182.

[45]North Atlantic Treaty Organization, *East-West Technological Cooperation* (Brussels, 1976), and North Atlantic Treaty Organization, *The U.S.S.R. in the 1980's. Economic Growth and the Role of Foreign Trade* (Brussels, 1978).

trol has continued, and it is exercised primarily through the State budget and the banking system. State enterprises are expected to remit most of their aftertax profits to the center, and these remittances makeup a substantial share of the State budget. Therefore, for capital construction and other forms of investment, enterprises must rely on investment resources returned to them via the State budget. This system, known as unified revenues and unified expenditures, has resulted in a lack of a direct connection between investment funds and economic performance, and has also been a source of inefficiency. Recent policies have attempted to overcome this problem by shifting from budgeted capital construction funding to loans supervised by the People's Bank.

Bank loans have, therefore, been used for overcoming production difficulties, and will be used more for working capital than for investment in capital goods. Reportedly, however, enterprises do try to get around banking regulations and use bank loans for capital stock. Because of the importance attached to physical output norms, enterprise managers seek investment funds. When these funds are available through the State budget, only depreciation, not interest, is charged. To meet production quotas, firms therefore have a natural tendency to pursue a relatively costless strategy of seeking vertical integration, especially the acquisition of well-stocked machine shops which can repair equipment received from the outside, or retool existing machinery.[46]

Such patterns of management have produced defects in the Chinese economy, including weak quality control, neglect of innovation, excessive vertical integration, and stockpiling—problems endemic to Soviet-style economies.[47] Not surprisingly, the Chinese have sought remedies for these kinds of problems. During the early 1960's, a number of reforms were implemented, and some of the current discussion seems inspired by the events of this period.

The reforms of the early 1960's were soundly denounced as revisionist during the cultural revolution. In fact, a series of these measures came to be called "the five soft daggers." They included the use of profits as the chief success indicator for enterprises; the subordination of "politics"-especially political campaigns and ideological remolding sessions—to production; the widespread use of material incentives; reliance on experts in factory management; and movement towards greater enterprise autonomy.[48]

Current economic thinking shows many similarities to the "five soft daggers." The leadership is concerned with achieving greater economic efficiencies and higher quality goods. It therefore feels that production goals should be expressed in value terms (such as profits) rather than mere physical output. The idea of "production first" also is now widely discussed; Deng Xiaoping has suggested that in the current historical period, putting production first is the key political task. Material incentives in the form of bonuses and wage increases have been reintroduced in the past 2 years (although not without problems), and expertise in factory management is being stressed with a consequent downplaying of the role of Party committees. Finally, new approaches are being taken to the principle of enterprise autonomy. In addition, it appears that at least one leading economist of the 1960's, Sun Yefang, has been rehabilitated following his cultural revolution disgrace, and has been asked to take the lead in designing six regional economic systems. The establishment of regional economic units above the province level is a step towards the assertion of greater central control over the local economy and the simplification of planning to achieve better economic results.

In an attempt to free up economic activity from restrictive bureaucratic control exercised by central ministries, China has reestablished industrial companies (reminiscent of the "trusts" of the early 1960's that *were*

[46] Rawski, op. cit., p. 183.
[47] Ibid.

[48] Bennett, op. cit., pp. 31 ff.

denounced during the cultural revolution), at least 15 of which have been established during the last 2 years. Companies are designed to rationalize internal commerce and contracts and to cut across vertical bureaucratic lines. They have responsibility for planning, production, and coordination in their respective fields. In addition, there are corporations which are "economic accounting units" and operate on the basis of profit and loss.[49] These serve as consultants for their respective parent ministries and foreign trade corporations on matters relating to the import of foreign technology. In any particular field there will be one corporation and several companies. As of late 1978, a partial list of corporations included: The China Agricultural Machinery Corporation, The China Cereal and Oils Corporation, The China Chemical Construction Corporation, The China Chemical Fiber Corporation, The China Coal Industry Technique and Equipment Corporation, The China Cotton Spinning and Weaving Corporation, The China Feedstuffs Corporation, The China Geological Exploration Corporation, The China Oil and Gas Exploration and Development Corporation, The China Petroleum Corporation, The China Radio Equipment Corporation, The China Railway and Technical Equipment Corporation, The China Seed Company, The China Shipbuilding Corporation, and The China Waste Materials Reclamation Corporation.

Recently, these have entered into direct contracts with foreign vendors. For example, the Chemical Construction Corporation was responsible for importing hydrocracking know-how from Lummus and purchasing eight synthetic ammonia plants from Kellogg in 1974. The China National Chemical Fibers Corporation evaluates petrochemical fiber technology from Europe, the United States, and Japan, and recommends which technologies China should buy.[50]

The reintroduction of the corporation form of organization has also been accompanied by calls for greater enterprise specialization designed to break down excessive patterns of vertical integration. Some Chinese economists are beginning to discuss a version of market socialism in which enterprise specialization would be matched by a much greater reliance on market mechanisms in the industrial economy. Currently they are at least officially forbidden. The approach to economic organization would also make use of contracts to enforce interenterprise agreements, and would rely more heavily on the banking system both for supplying investment capital and for enforcing economic discipline. These proposed reforms are at various stages of discussion and implementation. While some of them do in fact appear to be steps in the direction of great efficiency, quality consciousness, and innovativeness, they are unquestionably subject to opposition in a number of quarters, including provincial authorities and corporation officials.[51]

In sum, China's planning and management practices, and indeed the structure of the economy itself, are now in a state of flux, and it is difficult to predict how far or how fast economic reform might go. Those members of the leadership, including many of China's economists, favoring an aggressive pursuit of the four modernizations, undoubtedly favor significant economic reform. But there are others in the leadership who, while wishing to promote the four modernizations, are, for reasons of self interest and ideology, hesitant to encourage significant economic reform. This is particularly true of reforms that will emphasize profit, market exchanges, and more rationalized management practices. The ongoing debate bears watching. It will have a major impact at least on the pace, if not the character, of the four modernizations program, and will affect the extent of China's reliance on and capacity to absorb foreign technology.

[49] *China Business Review*, September October 1978, pp. 21 ff.

[50] Ibid., p. 22.

[51] Ibid., March April 1979, p. 56.

THE STRUCTURE OF ECONOMIC DECISIONMAKING

At present, the highest levels of economic policymaking take place in the State Council on the Government side, and in the Politburo of the Central Committee of the Communist Party on the Party side. The pinnacle of power in China is the standing committee of the Politburo of the Central Committee. While the body is clearly the locus of decision for issues of strategic national importance, studies of policymaking in China indicate that participation in policymaking is considerably broader. Of particular interest are various kinds of sectorial work conferences (that is, national conferences in a given functional area involving Central Committee members, and central Government and provincial government officials) and various kinds of meetings of the Central Committee itself. The State Council is China's cabinet. It interprets policy coming from the Party and oversees the work of the Government. Most high Government officials are also members of the Politburo, while most ministers are members of the Central Committee. Under the State Council are a series of specialized agencies, ministries, and commissions. Of particular importance in economic policy are the State commissions dealing with economic and technical affairs. These are SPC and the State Science and Technology Commission (STC).

SPC is the center of economic policymaking after the Central Committee and the State Council. The other planning bodies follow the SPC's policy; it approves the budgets of the other commissions which then make detailed plans within these budgetary guidelines. Reportedly, SPC has bureaus for production, foreign trade, communications, agriculture, and construction, as well as other bureaus corresponding to each ministry. It also has field offices at the provincial and municipal levels .52

STC, abolished during the cultural revolution, was reestablished in October 1977. A measure of the importance the regime attaches to science and technology in the four modernizations can be seen in that fact that a member of the Politburo was made minister in charge. STC is known to have a bureau for foreign affairs, a planning bureau, a policy research office, a bureau for energy and petrochemicals, a bureau for computers and machinery, and five or six other bureaus of unknown functions. These functions probably reflect the eight priority areas of the national science plan which was announced in early 1978—agriculture, energy, materials, computers, lasers, space, high energy physics, and genetic engineering. Prior to the cultural revolution, STC had an important role in coordinating national R&D activities, in science and technology planning, and in setting national standards.

The Chinese planning process involves both vertical plan development through the functional ministries and horizontal plan development through the provinces. While STC develops its own plans, it presumably also acts to provide specialized advice and information to SPC in the formulation of national plans. It is SPC that has the key role in turning national economic policy as specified by the Party and the State Council into a set of priorities, although little is known about how and by what criteria this is done. Nor is it entirely clear how technological requirements are set, although decision on incremental technological improvements and evaluation of the utility of technologies result from the downward and upward flow of planning information. The process of setting major new nonincremental technological requirements is less clear. On issues of major national importance, the State Council and the Central Committee undoubtedly play important roles, but information available to, and the strategic position of, SPC should ensure it a lead role in identifying at the policy level significant areas of technological need. In evaluating that need, particularly from the technical side, SPC has at

"Ibid., p. 14.

its disposal the competencies of the State Capital Construction Commission (described below) and STC. The latter can draw on the resources of the Academy of Science, ministerial research institutes, and professional societies.

DECISIONMAKING ON FOREIGN TECHNOLOGY

Predictably, given the multiple bureaucratic actors involved in making Chinese economic policy and managing the economy, there is no single or simple pattern of decisionmaking concerning the importation of foreign technology. Moreover, little detailed knowledge of this process is available in the West. Nevertheless with the growth in Chinese foreign trade and in the number of contacts relating to foreign technology, understanding of the decisionmaking process is increasing. Figure 16 represents a recent attempt by the CIA to summarize the decisionmaking procedure.

According to the CIA, the procedure begins with an initial request for foreign technology from provincial governments, individual plants, or industrial ministries. In addition, China has recently resurrected various types of industrial corporations that typically would be the end users of technology, and which undoubtedly generate their own requirements for foreign technology. Requests then go to SPC which approves the initiation of an investigation into obtaining technology. The SPC behavior presumably is guided by national economic policy directed from the State Council and the Central Committee, and by its own preliminary estimates and initial control figures for imports and exports based on overall economic goals and statistical information it has received from various sources." SPC works with the Ministry of Foreign Trade (MFT) setting priorities for foreign technology. Reportedly, MFT has responsibility for mapping out general import and export plans that accord both with foreign policy and with existing contractual commitments to foreign trading partners. Also taken into account are the nature of import and export commodities, world market conditions, domestic demand and export capability, and available foreign currency and external credits .54

According to the CIA, the State Economic Commission (SEC) also may initiate requests for foreign technology. SEC is responsible for the implementation of production plans approved by SPC on an annual and quarterly basis. It coordinates the supply and demand of industrial raw materials, energy, and other inputs. If domestic sources are unavailable it can turn to imports to overcome shortages. The SEC's activities in foreign trade are thus limited more to raw materials and other industrial inputs, than to plant and equipment orders.[55] But according to information received during a recent SEC mission to the United States, the Commission also has a bureau of technical affairs, and may, therefore, have a more active role in assessing and evaluating technology than had been thought.

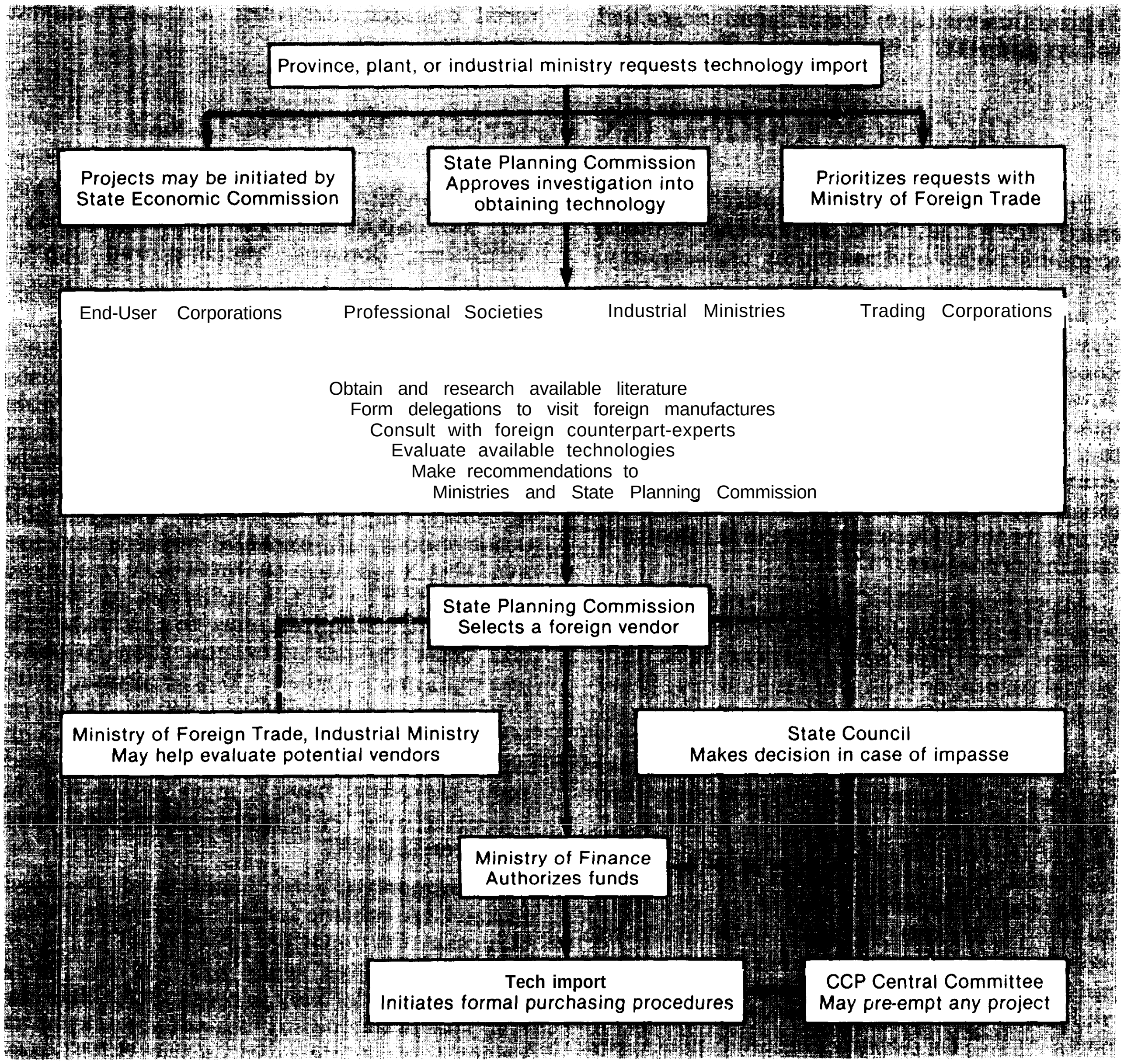
An important actor which is not included in the CIA scheme is the State Capital Construction Commission (SCCC), which probably coordinates with SPC in the early stages of the decision process. SCCC has the lead role in overseeing the administration of projects exceeding a certain size. SCCC coordinates the work of various ministries—for example, the Ministry of Metallurgical Industry with regard to steel investments. Once the SCCC's budget receives SPC approval, it coordinates investment plans of ministries, and in turn approves their investment budgets. SCCC has liaison bureaus for

[’y] ‘Gene T, Hsiao, *The Foreign Trade of China: Policy, Law, and Practice* (Berkeley, Calif.: The University of California Press, 1977), p. 74.

[54] I hid.

[55] *China Business Review*, March April 1979, p. 14.

Figure 16.—China: Technology Import Decisionmaking Procedure



SOURCE Central Intelligence Agency. National Foreign Assessment Center. China *Post Mao Search for Civilian Industrial Technology,* 1979 p 8

each ministry except agriculture. These include bureaus of coal, petrochemicals, machine building, petroleum, railroad, metallurgy, and water conservation and power. SCCC maintains branches at the local level.[56]

Unlike SEC, SCCC can initiate requests for plant equipment orders from abroad. It is likely that SCCC has become considerably more influential since the beginning of 1978. Some have speculated that it was the motive force behind the reconsideration of the four modernizations and the move toward more "balanced" and proportionate development as it began to aggregate the enormous capital construction requirements coming from various ministries.

[56] Ibid.

Once authorization for beginning an investigation for obtaining technology has been approved, the action shifts to other institutions. Until recently a lead role in this stage was played by the foreign trading corporations. These fall administratively under MFT which transmits to them guidelines for specific import and export plans. The foreign trade corporations add detail to the guidelines, and return them to MFT. Once approved, they become part of the general trade plans and, in turn, part of the national economic plan. Finally, after approval of the national plan by the State Council, MFT assumes ultimate responsibility for supervising the national foreign trade corporations in executing their specific plans.[57] However, at the search stage, industrial ministries, professional societies, and end-user corporations are also important. As the CIA has pointed out, these groups obtain and research available literature, form foreign delegations to visit foreign manufacturers, consult with foreign counterpart experts, evaluate foreign technology, and finally make recommendations to the ministries and SPC.

The Chinese have shown increasing sophistication in this search procedure, and a great deal of technology and technical information is transferred during this search stage. The Chinese have been making a coordinated national effort to accumulate as much written material as possible. The China National Publication Import Corporation procures technical titles from Western booksellers, and the Beijing Document Service was recently established to serve as a focus for a national technical information system linking the libraries of the Chinese Academy of Sciences, research institutes, ministries, and other organizations. The Chinese are interested in using the latest information-handling technology to provide a high-speed technical information network on a national scale.

The last 2% years have seen an enormous growth in Chinese technical delegations traveling abroad to Western Europe, Japan, and the United States. Some 2,000 Chinese technicians and officials have traveled in this capacity in 1977 and 1978. Members of these delegations appear to their Western contacts to be knowledgeable and well-informed. It has been suggested that these delegations are logically arranged in a serial fashion beginning first with "survey groups" which visit potential vendors to discuss technology and prices. They are the window shoppers who then report back their findings. Follow-on "study groups" then visit only a few selected firms chosen on the basis of the reports. These study groups engage in a more detailed investigation oriented toward the specific applicability of foreign technology to specific Chinese needs, and may be composed of individuals with greater technical expertise. The reports of the study groups become the basis for selecting a vendor.[58]

In addition, the Chinese have been inviting many Western firms and Western experts to present technical seminars in China, Reportedly, more than 250 such seminars were held during the first 6 months of 1978.'"

The results of these technical survey activities are widely discussed in China within the economic ministries. Additional technical advice is supplied by professional societies such as the China Chemical Society or the China Civil Engineering Society. Such societies occupy a strategic position in networks of information since they have contacts with foreign counterparts on one hand and they are linked to domestic industrial ministries and research institutes on the other. China's R&D efforts are vertically organized by production ministries, the Academy of Sciences, and the higher educational system. The professional societies on the other hand, draw their members from the vertically organized R&D sectors, and from production units. They thus appear to offer a significant horizontal linkage that may overcome some of the worst forms of "bureaucra -

' Hsiao, op. cit., pp. 74-5.

"(' IA, op. cit., pp. 3-4,

"'I bid., pp. 2-3.

tism" induced by strong vertical organizations.

Once the search and survey are completed, a recommendation is made to the ministries and the Planning Commission and the purchase is then factored into national economic plans. As the CIA scheme shows, MFT is again involved at this stage. SCCC also probably plays an important role in approving the selection of the foreign vendor. Depending on the scale of the project, the State Council may also be asked to intervene in the final stage of the decisionmaking process. Once approval of the project has been given, the Ministry of Finance, working through the Bank of China, must authorize funds.

Although it had been assumed that foreign exchange was closely controlled by the center, in the last few years individual enterprises may have had greater discretion than has been thought. Institutes of the Academy of Sciences have their own foreign exchange budgets, and reportedly allocations of foreign exchange to local production units for the purchase of foreign equipment have recently doubled. However, China has apparently been dissatisfied with authorization and control procedures for the use of foreign exchange which make it possible for buyers and users of technology to minimize their consultations with the Bank of China.[60] As a result, it was announced in April 1979, that a new General Administration of Exchange Control has been established directly under the leadership of the State Council.[61]

The final phase of the technology acquisition process is the initiation of formal purchasing procedures by a foreign trade corporation. The corporation most directly involved with acquiring foreign technology and responsible for importing whole plants and high-technology equipment has been the China National Technical Import Corporation (TECHIMPORT). While the use of TECH IMPORT and other corporations may facilitate central control, particularly control over foreign exchange, in the past these corporations have prevented direct contacts between vendors and end users. The Chinese seem now to be moving away from the use of middlemen by encouraging users to enter into direct negotiations with vendors. The foreign trade corporations may then take responsibility for administrative details. The first such contract signed with a U.S. firm was between Atlantic Richfield and the China Petroleum Corporation. The contract was signed on March 17, 1979, and provides for seismic survey work in offshore waters.

Another organization with a role in China's technology acquisition procedures is the China Committee for the Promotion of International Trade. Officially a nongovernmental body which nevertheless maintains close ties with MFT, it has helped establish and maintain contacts with foreign trading firms and agencies, and has also had a role in sponsoring foreign travel and exhibits in China. Its U.S. counterpart, particularly in the period prior to normalization and direct government-to-government contacts, is the National Council for U.S.-China Trade.

A final, and possibly significant, omission from the CIA scheme is STC. It is likely that, at least for some types of technology, this commission would play a role both in the initial stages and in the search and evaluation stages.

It is difficult to assess the effectiveness of China's decisionmaking processes for importing foreign technology. It is possible that the initial surge of interest in foreign technology in 1977 and 1978 exceeded China's decisionmaking capacity, and that one of the reasons for retrenchment evident in early 1979 was the realization that the multiple demands for foreign technology coming from the various sectors of the economy would exceed the PRC's ability to pay and to absorb. It is curious, however, that discussions with foreign firms should have gone as far as they did without apparent central control. One explanation for these events is that the new policies were intended to shake up the economic structure, and/or were part of strategy to encourage Chinese

[60] *China Business Review*, March April 1979, p. 3.
[61] *Beijing Review*, Apr. 20, 1979, p. 2.

economic managers to survey the technology available on world markets. An alternative explanation is that things did get out of control, and that only when SPC and SCCC began to aggregate the demands did China's top leaders begin to realize that the country's capacity to pay for and absorb technology was being taxed. The charge of inadequate management of the technology acquisition program is supported by the establishment of the General Administration of Exchange Control in April of this year.

The Chinese are clearly seeking a balance between central control and flexibility. The sanctioning of contracting authority for end-user corporations is a step in the direction of greater flexibility. It is also possible that with the greater liberalization of the economy described above, additional flexibility in foreign trade and technology acquisition will follow. For instance there have been reports of industries under local government control entering into product payback schemes with foreign firms on their own authority. It is likely, therefore, that a greater measure of decentralization in foreign trade can be expected. There are two caveats to this generalization, however. First, the central Government is likely to retain careful control over foreign exchange. Second, acquisition of whole plants and high-technology items is also likely to remain in centralized hands.

Apart from exchange control functions, the two main centers of authority for foreign trade appear to be SPC and SCCC, which reportedly "direct the work of the Ministry of Foreign Trade."[62] Undoubtedly the tasks confronting SPC and SCCC are numerous and complex since they have major roles in directing the domestic economy as well. Reportedly the personnel at SPC are of the highest quality. Unfortunately, it is impossible to determine the views of the SPC staff on the series of important matters of economic policy confronting China: the mix of heavy industry, light industry, and agriculture investments; the degree of technological self-reliance; the relative share of effort going to military work; etc. Officially, SPC carries out national economic policy handed down from above, but because of its strategic position in economic management it is presumably also in a position to influence the agenda of the top policy makers, there affecting policy itself.

Some sense of the operation of the technology acquisition procedures can be extracted from the following examples, which, however, are not intended to be typical examples of China's negotiating strategies.

Decisionmaking for acquiring foreign technology needed in Chinese scientific research is nicely illustrated in a recent report on the efforts of the Institute of Oceanography to procure an advanced research vessel. This project is reportedly one of the top 25 priority items in the new science development plan. The decisionmaking process involved an initiative from the Institute, approval from the Academy's central offices, and authorization from the State Council. The first phase took less than 1 year and was completed in December 1977. With this high-level authorization, the Institute began detailed studies of its objectives and its domestic capabilities for reaching those objectives, and concluded that the ship should be procured abroad. An interdisciplinary and interorganizational team was then formed to investigate the state-of-the-art in Japan and the United States. The delegation was abroad for nearly 6 weeks. Its recommendations will require the approval of the Academy of Sciences, which in turn will pass it on to the Ministry of Foreign Trade, and finally to the China National Machinery Import and Export Corporation, which will contact potential suppliers.[63]

A second example concerns a $5.2 million contract between TECH IMPORT and the High Voltage Engineering Corporation (HVEC) of Burlington, Mass., for the purchase of an HI-13 tandem accelerator to be

[62] *China Business Review*, March/April 1979, p. 14.

[63] Ibid., May/June 1978, pp. 9 ff.

used by the Atomic Energy Institute of the Chinese Academy of Sciences. In 1975, the Chinese initiated correspondence with the American firm. The corporation attracted Chinese attention because one of its founders had been Robert Van de Graff, a well-known figure in modern physics and the inventor of the Van de Graff accelerator. Nothing came of these initial contacts until 1978, presumably because of the confusion in Chinese scientific circles occasioned by the succession struggle involving the Gang of Four. In 1978, however, TECHIMPORT invited a representative from HVEC to Peking for preliminary talks. In July 1978, TECHIMPORT sent its own 10-man delegation to the United States to visit the firm and also one of its chief competitors. In August, HVEC was invited to Peking to discuss the possible installation of the HI-13 machine, and it sent its top people in engineering and management.

Photo credit: U.S. China Trade Council

13-million volt HI-13 Tandem accelerator, sold by High Voltage Engineering Corporation to the PRC

What was expected to be a 2-week visit lasted 32 days. The U.S. team met with its Chinese counterparts 35 times during this period, the Chinese inevitably outnumbering the Americans. Representatives from the Academy of Sciences as well as from TECH-IMPORT participated. The scientist members of the Chinese team produced a barrage of questions and kept seeking an improved version of the HI-13. According to the American side, the Chinese objectives were to extract the maximum technical information and to wear down the Americans with highly technical questions in order to enable TECH-IMPORT to get the best possible contract terms. The patience of the Americans wore thin, and on the second occasion that they threatened to leave without concluding the contract, the Chinese moved quickly to an agreement and the contract was promptly prepared. In the final 2 days while the contract was being typed, the Chinese asked the Americans whether they would be prepared to meet with a second group of end users who were also interested in their equipment. HVEC agreed, and this led to preliminary discussions on a second purchase.

The endurance of HVEC paid off. Not only was it able to incorporate favorable terms into the contract, but there is now potential for further business. Once assurance has been given that the equipment is not subject to U.S. or CoCom export controls, the Chinese will put down 15 percent of the price and will make installments at 6-month intervals with the last two 5-percent payments coming after demonstration and a 12-month performance evaluation. ”

A third example involves an engineering service contract between TECH IMPORT and Kaiser Engineers of Oakland, Calif. This contact was initiated when Kaiser sent a representative to China to give a paper on coal mine maintenance. At this time, the firm was not actively soliciting business in China. In March 1978, however, the Chinese contacted the firm via the PRC liaison office in Washington, to discuss the possibility of developing iron ore mines. Kaiser first ascertained that the Chinese were aware that they were purely an engineering service concern and then supplied the Chinese with information about their firm. After this material was thoroughly reviewed, TECHIMPORT provided Kaiser with sufficient information about its requirements to enable it to organize an appropriate team to go to China the following month.

As with the previous case, the Chinese subjected the Kaiser representatives to exhaustive questioning. Among the questioners was the Minister of the Metallurgical Industry. The Chinese were apparently satisfied with Kaiser's answers, for 1 month after the visit it obtained the contract from TECHIMPORT to develop two mines. One was an old mine that needed upgrading; the other involved opening mining operations at a new iron ore deposit. The contract is for 1 year and provides for one lumpsum payment. According to the contract, Kaiser is to do the general engineering, although there are also possibilities for detailed engineering developments. Kaiser has begun sending teams to China and also has been receiving Chinese engineers for training in California. Although Kaiser dealt primarily with the mining and metallurgical technology specialists at TECH IMPORT, they also had contact with the Chinese Society of Metals, confirming again the importance of professional societies in technology acquisition decisions.

Although there is undoubtedly considerable variation in China's approach to negotiations, on the basis of these and other cases, a few generalizations about the style of acquiring technology can be tentatively advanced. First, when technical requirements enter the decisionmaking process, efforts will be made, as in the oceanographic vessel case, to assess the possibility and desirability of meeting the need with indigenous technology. Second, these and other cases indicate that China prepares for its searches and negotiations with great care. Third, efforts are made to extract the maximum amount of information from the negotiations, and increasingly to use contractual ar-

[64] Ibid., November December 1 978, pp. 5-6.

rangements that will also yield as much information and experience to the Chinese as possible. For instance, it has been reported that China wants to change from fixed-fee to cost-plus contracts, which offer more intimate contacts with vendors. Fourth, the Chinese are hard bargainers seeking to get as much for their money as possible. As HVEC and other cases show, they sometimes use delaying tactics and gruelling negotiating sessions to wear down the seller in order to get better terms. Finally, China's search for technology and negotiating tactics may have political and diplomatic, as well as economic and technical objectives.

In conclusion, mention should be made of the technology transfers and knowledge flows that will result from the exchanges of students and scholars. While this area has generally been beyond the scope of export control legislation, it is important to recognize that such exchanges are mechanisms of transfer. The Chinese have estimated that as many as 10,000 students and scholars could be sent abroad for training by 1985. The exchange agreement with the United States provides for a target of 500 to 700 Chinese to come to this country to study during the first year of the agreement. Most of those who have come thus far have been midcareer research scientists. It should be noted that in keeping with the highly decentralized and pluralistic system of higher education in the United States, student and scholar exchanges are at present largely beyond most kinds of central U.S. policy controls.

THE ROLE OF WESTERN TECHNOLOGY IN THE CHINESE ECONOMY

Western technology has become economically significant in the PRC only in the past decade. For this reason, and because hard economic data for the PRC is extremely scarce (the population of the country was unknown until 1979), attempts at macroeconomic analyses of the economy would be meaningless exercises. The role of foreign trade and the technology component in that trade can only be treated anecdotally. In this area the most meaningful generalizations that can be made concern the potential, rather than past, impacts of trade with the West.

Chinese foreign trade presently involves the exchange of crude oil, coal, ores, foodstuffs, simple machine tools, textiles, bicycles and other manufactures for equipment and technologies for oil exploration, coal mining, steelmaking, chemical fertilizers, power generation, petrochemicals, and a small number of consumer goods. In addition, after 1961, bad harvests forced the PRC to import several million tons of grain from non-Communist countries, and it has continued this practice as an economical way of feeding its large northern cities.

The PRC reaps substantial gains from its comparative advantage in foreign trade. It exports items that have a high labor and natural resource content, and imports products that it could produce, if at all, only with great expenditure of high-technology resources. Its exports—specialty foods, silk, textiles, and high-grade handicrafts—command a high price abroad but are accorded low-priority domestically; with these earnings, it imports wheat, steel mill products, and electronics—items that command a comparatively low price in world markets, but are of great usefulness in running and expanding the economic machinery at home.

Foreign technology will provide the cutting edge of the general program for economic modernization discussed above. This technology will be most useful in the urban industries where large-scale plants are engaged in basic industry and military production. These plants typically are under central control, mass producing standardized products of tried a-rid prove-n design. They-tend not to be highly innovative. The quality of their products and production efficiency stand to benefit greatly from the import of modern process equipment and complete plants. In contrast, the medium- to small-scale enterprises that are typically under provincial or municipal control have been described as innovative and dynamic. Some of these are also important potential and actual end users of such foreign technology as production equipment and prototypes for adoption and copying.

In the 1950's embodied technology in the form of imported industrial goods from the U. S. S. R., particularly in complete plant purchases, was crucial in equipping basic industries such as iron and steel, transport, and mining. Imports were also responsible for the creation of virtually new industries, including machine building, electrical power generation, chemicals, and crude oil production. Soviet withdrawal, halfway through the agreed program, virtually halted China's industrial progress in some sectors.

The expansion of industrial imports in the 1970's is important, but not in the same way as that of the 1950's. The scale of total imports is now relatively small; for instance, the average value of imports of machinery and transport between 1970 and 1973 was below the average for 1952 to 1960. Further, since domestic output of these commodities has increased several times between the two phases, the imported share of the total value of deliveries of machinery and transport equipment has fallen dramatically.

But despite the low overall volume of industrial imports, their importance to the economy cannot be overemphasized. Not only have Chinese imports of complete plants risen from the 1950's, but these imports are crucial in the context of particular industries. In fact, nearly all of the $2.6 billion spent between 1973 and 1976 has been to support two industries: chemicals and steel. In chemicals, imports are adding over a third to the capacity of the chemical fertilizer industry, and in the case of man-made fibers and petrochemicals, imports are practically creating new industries.

The situation with respect to steel is different. This is a well-established industry that, due to planning errors, is technicall y inefficient and unable to satisfy domestic demand. Imports of finished steel products now account for over 90 percent of total Chinese steel purchases, paid for at the expense of machinery. The effect of steel plant imports should be to increase steel finishing capacity by a third as compared to the early 1970's.

The industrial imports are more important than their quantitative level suggests precisely because of their component of embodied technology, They have the capacity to provide a cumulative, quantitative improvement in Chinese industry. The Chinese, like the Soviets, acquire foreign technology in many ways. They read literature; they send specialists to study abroad; they encourage foreign firms to give expositions in China. They also purchase prototypes that they try to copy in substantial quantities. All of this is useful, although prototype copying has been more difficult than expected. For example, in 1963, the Chinese purchased a Dutch urea plant that they planned to replicate in a twin plant. They were unable to do so, and in general prototype copying has not so far proven feasible as a solution to technology acquisition. The Chinese have, therefore, had to purchase substantial quantities of equipment and to obtain the technical assistance necessary to adapt and integrate specialized equipment into their industrial systems. The remainder of this section deals with two industries in which this process has been facilitated by U.S. industrial exports; computers and oil drilling and exploration equipment.

COMPUTERS

The computer industry in the PRC has received relatively little attention in the West. Western computers did not begin to appear in China until several years ago, and relative-

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ly little information on this industry is available. Western sources are primarily limited to a series of trip reports which record the observations of delegations that have traveled in China in the past 5 years,[65] and a 1973 CIA report on computers in the PRC. The latter provided details on production facilities and on performance characteristics of many domestically produced computers.[66] The CIA material reveals the extent to which the Chinese computer industry before 1960 relied on Soviet assistance; the trip reports often provide excellent information on the present technical level of these computers. Nevertheless, discussion of this industry must remain incomplete and inconclusive.

[65] These are available through the National Council for U. S.-China Trade.

[66] Central Intelligence Agency, *The Computer industry in the People Republic of China*, National Foreign Assessment Center, 1973.

China produced its first computer in 1958 from designs provided by the U.S.S.R. Subsequent models were also based on Soviet designs or prototypes. The Sine-Soviet split occurred before the development of Soviet computers based on transistors, but the PRC was able to continue its domestic development. It produced a second-generation computer in 1965, only about 3 years after the introduction of transistorized computers in the U.S.S.R. A computer based on integrated circuits appeared within about 2 years of such models in the U.S.S.R. In 1974, the PRC announced the production of its first computer capable of 1 million operations per second. (In comparison, American computers were then operating with speeds of about 12 million operations per second.) The Chinese are presently capable of building computers with speeds higher than any reported Soviet computer in production.

Photo credit: Hsinhua News Agency

Testing calculators produced domestically in the PRC

This might suggest that the Chinese have been able to surpass the U.S.S.R. in computer technology, but the impression is misleading. The U.S.S.R. is capable of producing relatively large quantities under conditions of serial production, but virtually all Chinese computers are prototypes or small batch models. The stock of computers in the U.S.S.R. is at least 10, if not 20, times that of the PRC. Only a few factories in China produce more than a few computers each year, and only one of these is equipped with modern automated equipment for assembly and testing of computer components and final products.

As was the case in the U. S. S. R., the quality of Chinese computer peripherals and software lags significantly behind the performance of the central processing unit, thus limiting the effectiveness of the computer. This is an area that is currently receiving high priority, as is the development of better production capabilities to meet the demand for larger quantities of higher quality integrated circuits. At present, China's integrated circuits are about 7 years behind the state-of-the-art in the West, and the lag in production technology and production capacity is even greater. Although China has been able to close some of the gap in its production of advanced integrated circuits, it. has done so only in small-scale laboratory production. The methods used to achieve these results are outdated, the production process inefficient, and the number of devices that can be manufactured is limited. In order to meet this shortcoming, the PRC attempted to purchase a Japanese turnkey plant for the production of integrated circuits (ICs). This plant was to be part of a deal that included facilities for the production of color television sets. The IC portion of the project was blocked by CoCom restrictions. Nonetheless, the Chinese have begun to close the gap in the production of ICs. As their capability in this area increases, computer production will also begin to expand more rapidly. But, while the availability of better ICs is important to the production of new computers with very high speeds, the most important advantage of their increased availability will be to reduce the size and production costs of those computers already available in limited quantities in China.

Essential to the effective use of those computers produced in the PRC are improvements in the quality and range of peripheral devices. Available primary memory, for instance, lags far behind both Western and Soviet computers. Although access time is reasonably good by Western standards, the limited core memory is a great problem, especially in light of an even greater lag behind the West in other online storage capabilities.

Magnetic drums and magnetic tapes continue to be the predominant form of other online storage for Chinese computers. Magnetic disk use did not appear on a prototype computer until late in 1977. Thus far, there are believed to be only two models capable of making use of disks for storage, and those disks that are available have a capacity one-third that of the best disks now being produced in the U.S.S.R. and Eastern Europe.

In addition to problems with insufficient memory capacity, Chinese computers are limited in the rate at which information can be fed into the computer and put out by the system. The principal forms of input continue to be keyboard and papertape readers. There has been no evidence of the use of cardreaders, which would represent a significant improvement over the current state of input technology. This is a particular liability for problems that involve large data-handling requirements, or frequent updating of data banks. Such tasks are also difficult for Chinese computers since they place a high demand on the availability of a range of high-quality output devices,

The Chinese produce standard line printers in quantities that seem to meet their demand but, at 600 to 800 lines per second, the unit is slow by Western standards. A newer model, which employs electrostatic printing technology and has a speed of 1,800 lines per minute, has appeared in the most advanced computer prototypes, but is unlikely to be widely available soon. The availability of other terminals and output devices is similarly limited, and those that are produced employ early technology.

The small number of standardized computer models has delayed the development of software, a situation similar to that in the U.S.S.R. prior to the introduction of Ryad. Efforts are now focused on extending the repertoire of the languages most commonly used in the West and on training programmers in adapting programs for use in different models.

The architecture of the first series of Chinese minicomputers seems to have been based on an American prototype, but the second series was almost certainly designed by the Chinese themselves—after extensive examination of the architecture of both IBM and Control Data computers. The goal for this second series is to achieve software comparability and program interchangeability, but there are indications that different factories producing the same model are using different hardware designs.

Since the cessation of extensive transfers of technology from the U. S. S. R., the Chinese computer industry has received very limited assistance from abroad, in either manufacturing technology or computers themselves. In fact, no country appears to have transferred computer manufacturing technology to China since 1960. This partly explains the comparatively slow progress of the Chinese in serial production relative to their progress in the design of prototypes. Limited imports of Western computers took place during the mid-1960's, but no complete or detailed survey of the sales from this period, or for the 1970's, is available.

France and Britain both sold several computers to the PRC between 1964 and 1967, before imports of virtually all Western technology were blocked by the policies of the cultural revolution. These systems went to several different end users for seismic data analysis, process control, plant automation, and medical research. The two largest are believed to be in Beijing's Central Statistical Office. The primary source of demand throughout the 1970's has continued to be plant automation and data handling or analysis.

Accurate figures for computer imports during the 1970's are unavailable, but it is unlikely that major orders were placed before 1973, and these have remained quite limited since. Orders during 1973 and 1974 probably amounted to about $6 million to $7 million per year, rising about $25 million for each of the next several years. During 1978, these figures rose dramatically, primarily as a result of a single $69 million contract with an American firm, but imports much in excess of $100 million per year are considered unlikely.

China desires to be as self-sufficient as possible, but difficulties in serial production of computers are likely to persist. Imports of individual Western models will contribute much by providing computers with large data-handling capabilities for networks that involve data transmission and the use of remote terminals, and for various business and advanced scientific uses. The acquisition of software and the increased exposure of Chinese programmers and users to Western technology will also aid the Chinese in the advancement of their own software capabilities. Imported computers will be placed in high-priority areas, but less-than-critical users will have to await improvement in domestic manufacturing capabilities. Thus, China has little interest in purchasing many small- or medium-size computers. These will be produced domestically; until then, end users will do without.

A shift in the primary motivation behind the selection of computer imports appears to have occurred in recent years. The demand for computers with specific applications, particularly in the all-important petroleum industry, indicates a preoccupation with the specific services rendered by individual computers rather than more general software acquisition. Most other computers imported by the Chinese have been for process control at imported turnkey plants, or for end uses for which domestic computers are not particularly well-suited—analyses of weather data, computers and terminals for the Bank of China, and air traffic control.

On the other hand, some imports are motivated primarily by the desire to obtain prototypes for domestic production. Minicomputers probably fall into this category. The secondary benefits of all imports, moreover, lie in the exposure they provide to terminals, peripherals, software, etc. Any Western computer, therefore, may ultimately help in the design of better Chinese products.

Western export controls place a severe constraint on the purchase of computer manufacturing technology. They also limit the sale of systems with certain performance characteristics. Relaxation of these regulations would almost certainly result in the allocation of greater amounts of foreign currency for the purchase of large, advanced Western computers in high-priority sectors. Access to these systems would provide technology surpassing China's present technical frontier and specific capabilities to benefit the entire economy.

Little is known about the criteria employed in selecting Western suppliers. As in the U. S. S. R., the most important factor seems to be the desire to obtain the best available technology. In many cases this would point to American suppliers, despite the difficulty of obtaining U.S. export licenses. For example, **a** Japanese firm recently contracted to supply computers for the Chinese Meteorological Center, but only after an American computer firm withdrew from negotiations for export control reasons. When the contract was signed by the Japanese, the United States tried to block the sale through CoCom. Safeguards were added and the sale was ultimately approved. At the moment, the Chinese have no difficulties obtaining financing, although this may change as their hard-currency debt grows (see chapter III). Thus, the only other factor influencing choice of supplier may be the special relationship between the PRC and Japan. The Japanese are willing to provide the Chinese with large amounts of sophisticated technology. In the future, this may include manufacturing technology for the production of computers or peripheral equipment. The Japanese are more likely to agree to supply such technology than any other Western country (see chapter IX) and further enjoy the advantage of their experience with the character alphabet. It is likely, then, that the two most important sources of computer technology for the Chinese will be firms from the United States and Japan.

It is still too early to determine the impact of Western computer technology on the Chinese economy. Although the imports of the 1960's clearly aided the design of later domestically produced computers, no Chinese models seen since closely resemble Western prototypes. The major effect of Western technology so far has been as a source of information and starting point for R&D within the domestic computer industry. The lack of direct transfers of manufacturing technology is the most important factor affecting future impacts.

It will take time for the Chinese to make full use of imported technology. Some Western computers remain advanced beyond the understanding of many of the people working with them. The adaptation and diffusion of the technology embodied in accompanying software is likely to be more rapid than that of the hardware. Again, however, there will be significant lags before the availability of this software has an appreciable effect on the ability of the Chinese to generate their own software capabilities.

OIL AND GAS

The oil industry, like most other sectors of the economy, was extremely underdeveloped in 1949, when the PRC came into existence. Levels of production were very low and China had relied heavily on imports to equip its small domestic industry. Potential reserves were believed to be inconsequential, and much of the country had not been fully explored.

During the 1950's, due primarily to the efforts of the U. S. S. R., this picture changed considerably. One of the most important forms of assistance provided by the Soviet Union was in training. Between 1950 and 1958, some 8,000 skilled workers, 6,500 students, and about 1,000 industry experts from China were trained in the Soviet Union. The data does not show how many of these were involved in the oil industry, but it is known that about 450 Soviet petroleum experts were sent to the PRC to provide technical assistance.

In addition, the U.S.S.R. provided large amounts of equipment to the Chinese oil industry. Imports from the U.S.S.R. and Eastern Europe accounted for nearly 65 percent of all equipment supplied to this sector during the first 5-year plan (1953-58).

By 1954, China had begun expanding its production of basic tools and parts (e.g., oil-extraction drilling tools, pumps, and small compressors), but it was not until the U.S.S.R. helped it to establish several large plants for the production of oilfield equipment that China's output began to expand significantly. By 1958, using Soviet models, the Chinese had increased production of oil industry equipment.

All Soviet technical help was withdrawn and equipment sales virtually ceased in 1960, although Romania remained an important source of oil and gas technology. The loss of Soviet aid was sorely felt, however, particularly in the area of geological prospecting. The U.S.S.R. had provided extensive help in carrying out a number of serial magnetic, gravity, and seismic surveys. These had led to the identification of the fields that have since become the center of China's industry.

The most important oil reserves in China now, and for the past two decades, have been the Taching fields in the northeast part of the country. The U.S.S.R. began prospecting in this area in 1955, and drilling began in 1958. Fortunately, most of the wells drilled during the first years were relatively shallow and did not tax the capacities of domestically produced rigs.

After 1960, research programs aimed at improving technological levels in the oil industry were begun and many of these centered on the analyses of the available foreign equipment. These efforts paid off. From 1962 to 1963, China's output of oil equipment increased by more than 60 percent. By the following year, 1963 production was more than doubled.

But the equipment now being produced, primarily for shallow drilling, was patterned primarily on Soviet and Romanian design which lagged behind the technology employed in the West. The Chinese made only very limited use of equipment imports from the West before the 1970's. Although small purchases were made from Japan and France there were no direct sales by the United States until after 1972, although there is evidence that some American equipment designs were used by the Chinese to aid in the development of domestic designs. This technology was acquired either through equipment sales from third parties, or through foreign equipment incorporating U.S. technology.

Detailed knowledge of equipment and oil production in China is limited in the West, where, again, trip reports are among the few sources of information. Furthermore, because most Western oil technology was not acquired until after 1972, its full impact on production and the level of domestic equipment development has not yet become apparent.

According to most Western oil industry experts, the technology being employed by the Chinese for geological prospecting, drilling, and production is about at the level of U.S. technology circa 1950. The Chinese themselves estimate that their technical capabilities in various phases of the oil indus-

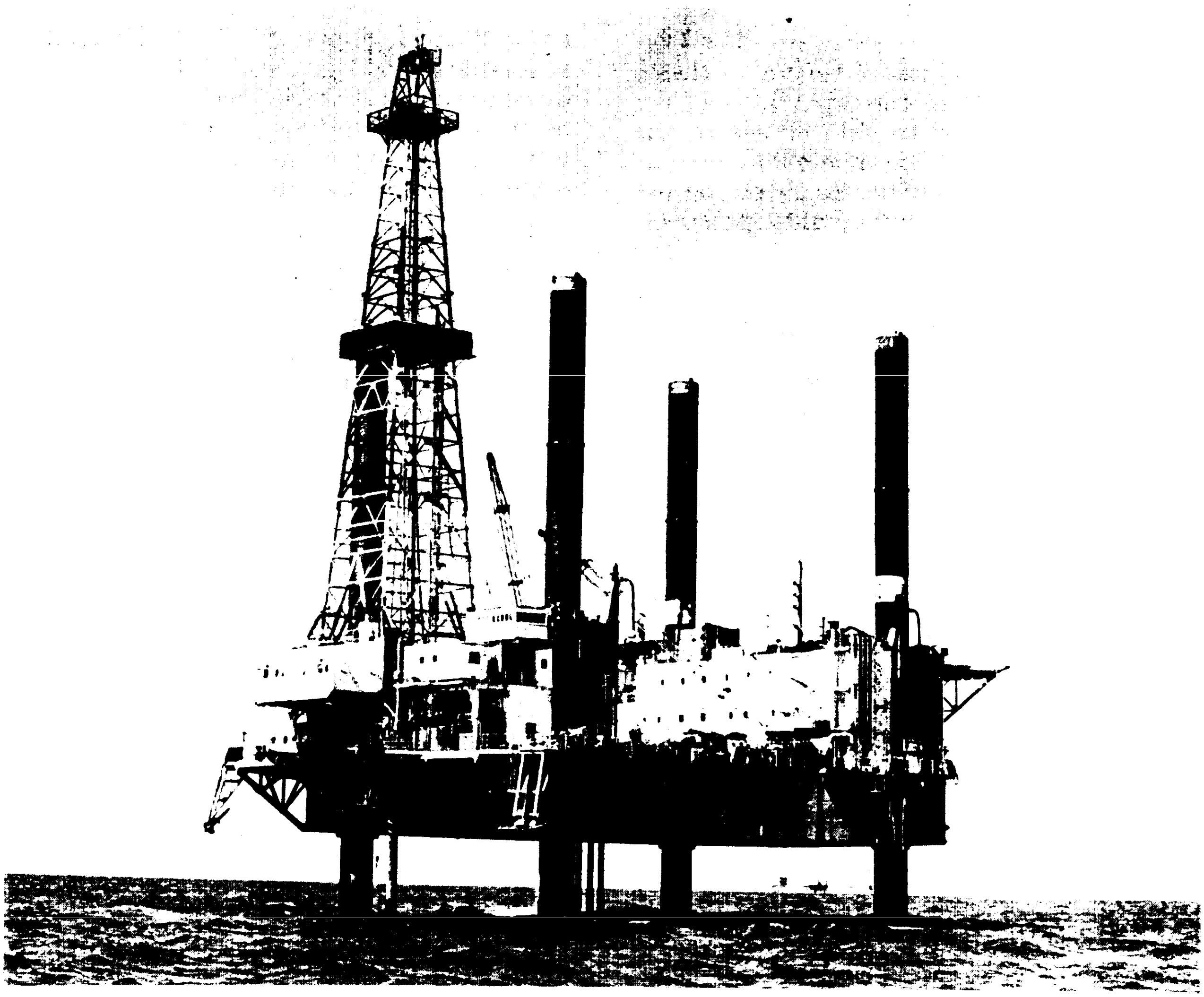

Photo credit: U.S. *China Trade Council*

Drilling platform in the Pohai Gulf

try lag behind Western state-of-the-art by 15 to 20 years. Often, Chinese oil equipment technology has been copied or adapted from the dated technology of the U.S.S.R. or Eastern Europe. China, therefore, experiences many of the same problems in this sector as the U. S. S. R.. although often on a larger scale. Geological prospecting technology is unsophisticated, and this limits the usefulness of other activities. Further, the Chinese seem to lag the Soviet Union in deep-drilling capabilities, the level of most well-completion equipment and automation of production facilities could be significantly improved and technical assistance is sorely needed in offshore operations.

Much of China's oil reserves still lie undiscovered, and domestic prospecting equipment is inadequate to this task. The geology of China's three largest fields, Taching, Shengli, and Takang, involves complicated structures, the result of unpredictable fracturing which has left oil dispersed in a number of small pools. Efficient exploration requires sophisticated prospecting equipment, including such equipment for the collection and analysis of seismic data as computers with specially designed software. The Chinese have already imported several of these, in order both to obtain the capabilities of the equipment itself and to gain access to the software. It will be some time before domestic production is adequate to meet the demand for large-scale high-quality prospecting equipment.

Most of the geological prospecting equipment imported by China thus far has come from the United States, which sells the best technology available in the field. The National Council for U.S.-China Trade has estimated that such sales totaled nearly $40 million between 1973 and mid-1977.

At the end of 1977, it was reported that workers at the Shengli oilfields had both greatly increased drilling speeds and reduced costs by 50 percent by using domestically produced synthetic diamond drill bits and high-pressure jet drilling techniques. Western drilling and well-completion technologies that might lead to further improvements are mud technology and cementing. Drilling-mud lubricates the cutting bit, aids in removing waste material from the well, and seals the borehole. In the West, a variety of chemical additives for the mud are available, but a more primitive practice is to mix soil with the fluid being pumped into the well. The Chinese primarily use the latter technique.

There are also indications that significant improvements could be made in the cementing operations necessary for well completion. Present cementing methods are predominantly either domestic or imported from Romania or France.

There is no detailed information on quality of Chinese wellhead equipment or the number of operating wells. Whatever their number, several production problems are being encountered. Most Chinese oil has a high paraffin content. This means that extractive equipment must be heated during the winter to maintain oil flow. Other production problems arise from the high water content of the oil and from complex geological structures. By early 1979, 85 percent of the oil output of at least one field was measured and recorded by computer, but there have been no reports of automatic metering at other fields, and very little evidence of automation of any other aspects of field operations.

The Chinese claim to be relatively advanced in their understanding and use of water-flooding as a means of increasing well production, but there is evidence, for example, that injection control and the monitoring of injection performance remains limited. In the West, water injection is used heavily in mature or declining fields. In both the U.S.S.R. and the PRC, however, water injection is often used at new fields and with recently completed wells. This may increase the initial rate of production, but it also reduces the ultimate recovery rate from the reserve. Because the reserves at China's major oilfields are fragmented into small pools, it is difficult to know whether low pressures at a particular well is symptomatic of the state of the field as a whole. Low wellhead pressure would indicate that rapid growth rates from the field cannot be achieved by modern technology alone.

Initially, China depended heavily on the U.S.S.R. for assistance with drilling and extraction of onshore reserves; the Soviets provided both equipment and assistance in the manufacture of equipment. Eastern Europe's technological contribution to the Chinese industry was relatively minor at this time. The role of the West was virtually nonexistent.

During the 1960's, after the U.S.S.R.'s importance to China as a source of drilling and extraction equipment drastically declined, the Chinese continued to rely on the Soviet equipment already in place, using it as models for domestic production. In the 1970's, China turned increasingly to the West for both equipment and technology to improve and expand domestic production, but as yet there have been no sales of turnkey plants for production of oilfield equipment. Earlier, Chinese desire for self-sufficiency led them to accept delivery of equipment without participating in training on operation and maintenance. More recent sales have included such training, however.

Most sales of drilling and extraction equipment from the West to the PRC have come from American firms, but Western sales of onshore drilling and extraction equipment through mid-1976 totaled only about $13.4 million. The pace of these purchases has since been stepped up. The Chinese oil equipment market is now highly competitive, and many Western companies competing in it are reluctant to discuss the details, particularly the value, of recent sales. Accounts of oil equipment sales can, therefore, be assumed to understate the true volume of equipment and technology transferred.

An upswing in Chinese equipment purchases for drilling and extraction of onshore reserves has occurred over the past few years. In 1978, the Chinese bought a wide variety of drilling and extraction equipment. One French company has signed a $22.9 million contract for drilling equipment, but all other major sales are believed to have been made by U.S. companies. Sales have included $10 million worth of drill bits, drilling tools, submersible pumps, down-hole instruments, and wellhead equipment. In some cases, China has chosen to pay a higher price in order to gain access to the latest technology. For example, it has purchased drill bits with tungsten-carbide cutting structures and a new bearing design. These are said to last three to four times as long as previous designs and are particularly important to help China with deep drilling.

China also gained access to a variety of other equipment to help improve drilling performance and extraction capabilities. It has purchased $100,000 worth of petroleum-handling tools, $7 million worth of workover rigs and blowout preventers, as well as unknown values of down-hole instruments, wellhead and well-completion equipment, well-testing instruments, and other equipment. Much of this has been bought in limited quantities, suggesting that China is seeking primarily to import prototypes for duplication.

The total value of 1978 contracts for which values are known is about $50 million. These figures indicate that China is likely to continue looking to the West as a primary source of drilling and extraction technology, although Romania may continue to be an important source of technology and equipment for drilling rigs and cementing equipment. While purchases from the West are made primarily for the embodied technology, purchases from Romania are used to obtain supplies of currently needed equipment.

Serious difficiencies exist in Chinese prospecting, drilling, and extraction methods and equipment, yet China has successfully developed several major oilfields, and reached a production level of about 200 million tons per year. This is about 25 percent of U.S. output. Extensive reserves of oil and possibly natural gas, still largely unexplored, are believed to exist in fields in the interior of China and in its offshore waters. To exploit the interior fields, China must use deep-drilling equipment. Heretofore, little deep drilling has been carried out; the development of these fields has been delayed, primarily by the tremendous cost involved in building long-distance pipelines to transport the oil.

Delays in offshore production result more from technological problems. The Chinese (as the Soviet) oil industry lags farthest behind the West in offshore technology. China's first offshore drilling activity began only in the late 1960's, when limited drilling was undertaken from fixed platforms in shallow water in the Pohai Gulf. The Chinese have relied extensively on foreign technology for offshore geological prospecting capabilities, purchasing entire vessels as well as smaller pieces of equipment. Two of three prospecting vessels in use in offshore waters in 1976 were outfitted by copying Western equipment.

A large program to import Western offshore equipment was begun in late 1972, starting with the purchase of a Japanese jack-up drilling rig and accompanying workship. The value of orders, all placed with the West within little more than a year, came to more than $175 million, a figure greatly exceeding the total value of all Chinese equipment then in use for offshore exploration and development. Most purchases were for equipment that embodied high technology, but in some cases–dredges, for example–the technology is not sophisticated. Some of the PRC's decisions to import rather than build such equipment can be attributed to a desire to begin using the equipment quickly. This approach typifies the Chinese use of Western imports to fill production gaps as much as to fill technology gaps.

The orders placed in 1972 and 1973 for oil industry equipment ultimately resulted in a sharp drop in foreign exchange reserves, and the drive for offshore equipment contracts from the West greatly abated thereafter. The decision to cut back imports was partially the result of traditional Chinese conservative fiscal policy, but the political uncertainties as rival political factions battled for position before and after the death of Mao Zedong were also factors. This political conflict made planners more cautious, particularly since reliance on foreign products and technology was *a* central point over which the two sides disagreed.

Despite this retrenchment, equipment imports for offshore needs totaled at least another $125 million through mid-1977, reflecting the priority accorded them. They continue to dominate oil industry equipment purchases. Over the past 2 years, Chinese orders for Western offshore equipment have again risen sharply. The PRC decided to make much greater use of Western technology in high-priority industries as Chinese foreign exchange reserves recovered and the industry had more time to assimilate foreign technology that had already been imported. Preliminary estimates for the 2-year period from mid-1977 to mid-1979 indicate Chinese orders for more than $275 million in offshore equipment, about 80 percent in drilling equipment.

Geological prospecting has generated a great deal of interest as the first area in which Western firms have considered going beyond equipment sales and training. A number of major U.S. oil companies, along with representatives from Japan and several European countries, have discussed the possibility of assisting the Chinese directly with exploration, and even production, of offshore reserves. The most important roles in such cooperative ventures are likely to be played by Japan and several American oil firms.

By early in 1974, three U.S. oil companies—Exxon, Phillips, and Union Oil of California–had signed a "group shoot" exploration contract, in partnership with the foreign-owned firms of Shell, Elf-Aquitaine, and British Petroleum (project leader); and Atlantic Richfield became the first American firm to sign a contract for sole exploration of Chinese prospects. Other companies are also expected to enter the market, since it appears that the Chinese are willing to permit extensive Western involvement in offshore development. Reportedly, the Chinese have not imported any turnkey plants for the production of offshore or onshore oil equipment, but moves in this direction may be underway.

The Chinese have clearly made a serious commitment to the development of their offshore oilfields. They realize that the active acquisition of Western equipment, technology and experience will significantly speed the development process. It maybe that Chinese experience in this stage of offshore development will help to shape the size and direction of Western involvement in China's onshore oil program.

Until 1972, the amount of Western technology transferred to the oil industry was limited by conscious policy decision. Yet even then the Chinese recognized their need for such technology. They had relied heavily on the U.S.S.R. during the 1950's, and later on Romania, particularly for deep-drilling equipment. There is ample evidence that individual pieces of equipment have been copied by the Chinese from Western, and particularly American, models. Several oil industry experts believe that the Chinese could make very effective use of greater transfers of technology from the West in several areas of the onshore oil industry. The Chinese have reportedly made detailed studies of the state of Western technology, and are likely to make a greater effort in the future to increase its acquisition. Shortages of seismic equipment and computerized field units are posing serious problems for the geological prospecting sector in locating deeper reserves. Improvements in drilling instruments could produce important changes in performance by raising the effectiveness of the limited number of available rigs. The Chinese have limited experience with secondary recovery methods other than water injection. Greater experience with alternative techniques could produce results without a major need for additional equipment.

It is still too soon to assess Chinese capabilities to absorb the technology embodied in purchased equipment. Some experts point to the low level of experience of the average oil industry workers and express doubts as to the level at which this equipment can be operated and maintained. Imported equipment used in technical schools and colleges for training may ameliorate this problem.

CONCLUSIONS

Transfers of foreign technology have influenced both the level and direction of economic progress in the PRC. In the immediate postrevolutionary period, Soviet equipment and expertise contributed heavily to Chinese industrialization. With the intensification of the Sine-Soviet rift in 1960 this source of technology was eliminated. Imports of technology did not again play a significant role in Chinese growth until the mid-1970's—this time, however, through transfers of plant, equipment, and associated technology from the West. Japan has been the major beneficiary of the process; thus far, the United States has succeeded in garnering only a small (7 to 8 percent) share of PRC imports.

China's imports from the West have been crucial to the development of key industrial sectors such as steel and petrochemicals. China's modernization drive, although significantly less ambitious now than as originally announced in February 1978, depends on imports of plant and associated technology to play an important role in strengthening the industrial infrastructure, raising productivity in the agricultural sector, and in the exploration and development of energy resources. While Japan will undoubtedly benefit most from this drive in terms of increased export receipts, the United States can significantly increase its share of Chinese purchases through a normalization of trade relations as well as extension of official export credit facilities.