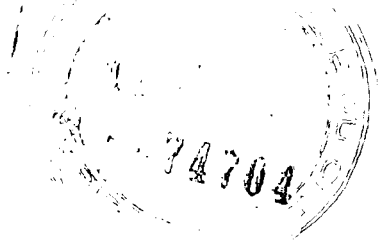
Giri Deshingkar

I. SCIENCE POLICY OF THE PEOPLE'S REPUBLIC OF CHINA



The People's Republic of China (PRC) has pursued quite different strategies of economic development at different periods, depending on the political "line" in "command" in which the strategy of economic development was formulated. The political conflicts over the "correct line" of development within the Chinese political leadership have affected all sectors of China. Consequently, the organization and administration of science and technology in the PRC has also been subject to major policy shifts since the establishment of the Communist Party ruled regime. In this essay I propose to analyse the shifts or developments in China's science policy since 1949. For the sake of convenience of analysis, I have divided the entire period roughly into five stages - 1949-1957, 1958-1960, 1961-1965, 1966-1977 and the post-1976 period - each distinguished by a major shift in economic and science policy.

The shifts in China's science and technology (S&T) policies did not come about solely as the result of pragmatic considerations. The Chinese leaders guiding the "Chinese Revolution", of course, wanted to use S&T to transform their technologically backward country into one which was technologically advanced and economically prosperous. Their vision of the socialist China of the future

included military strength based on modern weapons and equipment, a comprehensive industrial system which could produce almost all the industrial products the Chinese society needed, modern means of rapid and efficient transportation and, as a back-up to all these, an agricultural system which could not only feed and clothe China's growing population but also produce the necessary surplus for all-round development. The question was how to do this in the shortest possible time. The Japanese model of rapid modernization was obviously not acceptable to China's Marxist leaders; it was a capitalist model which moreover had produced militarism. The only other available model was one implemented by Joseph Stalin. From the very beginning, however, the Chinese leaders showed great ambivalence towards the Soviet model. This led to serious ideological conflicts within China over the S&T policies. These are discussed separately in a companion essay which is intended to serve as complement to this one.

The Initial Years: 1949-1957

The "People's Liberation Army" of the "Chinese Communist Party" won a decisive victory over its adversary, the Guomindang (Kuomintang) armed forces in the Chinese Civil War and established the PRC in October 1949. This new regime inherited a badly disrupted as well as a generally underdeveloped economy. The level of industrialization was extremely low, agriculture was based on traditional methods and the system of science education were also very "backward". The major

objective of the new regime was, therefore, to restore agricultural and industrial production, such as it was, to the pre-war peak levels. The PRC's initial years were essentially those devoted to recovery rather than to development. Even the few scientific researchers which existed were not, therefore, called upon to render any positive support to the production sectors during these years. However, the Chinese leaders were already making plans for the future. These were based on Soviet experience and indeed on Soviet expertise. Consequently a certain amount of preparatory work was done to lay out the basic groundwork for developing a comprehensive Research and Development (R&D) infrastructure. As a part of this the Chinese government proceeded to acquire the necessary research facilities. Chinese scientists, technologists, and other intellectuals residing in foreign countries were requested to come back and help in China's reconstruction programmes. The new regime placed major emphasis on reorganizing and consolidating the research activities which were under way before 1949; only moderate efforts towards initiating new and serious research programmes were made during this period.[1]

Since policies to promote scientific and technological R&D on a national scale could not be implemented without appropriate and effective institutional structures, the new regime, soon after the proclaimation of the PRC, gave top priority to building a comprehensive infrastructure for scientific and technological development. The Chinese Academy of Science (CAS) was established in

November 1949, within a month of establishment of the new regime, by merging the remnants of the existing Academia Sinica and the Peking Academy of Sciences. (Many scientists had fled the country fearing the Communist rule.) Subsequently in 1954, an Academy Secretariat, similar to the Secretariat of the USSR Academy of Sciences, was organised. This Secretariat, on the basis of Soviet advice, was given extensive administrative authority in all S&T and R&D matters. Further, the CAS was organised into five "academic departments" patterned after those of the USSR Academy. The CAS became the national agency to plan R&D activities, recruit and train scientific and technological manpower, reorganize and consolidate the already existing research facilities, and to engage in new scientific research.[2] Research Institutions again patterned after their Soviet counterparts, were also set up in various ministries. The chief among these were the Ministries of Defence, Agriculture and Public Health. Each possessed an independent system of R&D activities under a separate science academy. A National Defence Scientific and Technological Commission was also set up under the People's Liberation Army to organize and promote military R&D. The Chinese experience with advanced American Weapons in Korea had made this an urgent task.

Besides these research institutions, two separate non-governmental organizations -- the National Federation of Natural Science Societies and the National Association for the Dissemination of Scientific and Technical Knowledge -- for the promotion and popularlization of science were formed in August 1950. The National Federation, following its Soviet counterpart, actively promoted scientific activities, reorganized the science societies

established before 1949 and set up new science societies mainly in the fields of applied R&D. These societies played a very important role in coordinating research under the CAS and the needs of national construction.[3] The National Association, on the other hand, was mainly responsible for popularization of science and dissemination of knowledge on agriculture, medicine and public health among China's scientifically untutored masses.

The CAS at this time, like its counterpart in the Soviet Union, was not only the prime organization conducting scientific research, it was also the centre for science planning and administration. After 1950, each research institute under the CAS was required to draft its annual research plan for the next year. Comprehensive long-term science planning in China, however, began only in late 1952; this was in preparation for China's First Five Year Plan (1953-57). Soviet specialists assisted China in all phases of the First Five Year Plan as the Chinese Government relied heavily on Soviet experience and advice during this period. Contact with the Soviet scientists convinced China's scientists and science administrators of the importance of long-term S&T planning. Preparatory work to draft a long-term comprehensive science plan began in December 1955 and with the help of a number of specialists from the USSR Academy of Sciences, Chinese scientists and administrators completed the Twelve-Year Plan for the Development of Science and Technology (1956-1967) around June 1956.[4]

The Twelve-Year Science Plan was never made public; Chairman Mao Zedong and some other leaders of the CCP had, by 1956, already developed deep doubts about the Soviet

model. But it is known that it contained a set of clear priorities. An important objective of the Plan was to achieve balanced development in all fields of science and technology and to attain international standards in most advanced fields of science by 1967. The following areas were particularly stressed: peaceful uses of atomic energy, radio electronics, jet propulsion, automation and precision instruments, petroleum and scarce minerals exploration, metallurgy, fuel technology, power equipment and heavy machinery, problems relating to harnessing the yellow and the Yangze rivers, chemical fertilizers, mechanization of agriculture, prevention and eradication of epidemic diseases, and "important problems" of basic theory in natural sciences.[5] These priorities show that the Twelve-Year Science Plan was heavily oriented towards research projects of an applied nature. All the selected areas, except the last one, were relevant to the development of highly sophisticated modern technology; only one pertained to research in basic theory. Although the Twelve-Year Science Plan was intended to unfold over the years 1956-1967, it was, according to later Chinese sources, "fulfilled" ahead of schedule in 1962. However, it seems that failure of the "Great Leap Forward" (1958-1960) and the withdrawal of Soviet aid after 1960 adversely affected the implementation of the Plan. Many projects were either cancelled, abandoned or "readjusted".[6] After 1961 feeble attempts were made to pick up the threads of the Plan but it is unlikely that it ever got fully implemented during the period of "readjustment" which extended to 1965, the eve of the Cultural Revolution.

Initiation of long-term S&T planning, expansion of research activities in various economic ministries, and the phenomenal increase of overall budgeted expenditure for science called for major changes in China's scientific establishment. The need for a high-level science organization for planning scientific research, integrating science and economic plans, and coordinating interdisciplinary research and the work of various research sectors was acute. The CAS was not equipped for such a gigantic task. Hence the Chinese Government set up, in March 1956, a high-level Science Planning Commission.[7] Two months later, in May 1956, a State Technological Commission was also set up to plan activities in technological fields including the designing and installation of pilot plants and machine prototypes. Following the establishment of the Science Planning Commission, science planning committees were established in provinces, autonomous regions, and muncipalities to draft and execute science plans with respect to the problems and activities affecting their areas, those that were not included in the national plan.[8]

Within the five years between 1952 and 1957, China achieved almost a miracle in bringing modern science and technology to China. It built an infrastructure of basic industries like steel, chemicals, coal etc. A comprehensive military production system was established. Science and technology education made great strides. An ambitious programme of river control was started. Minerals exploration began on an unprecedented scale. Epidemics were virtually eliminated. It was spectacular progress on a

wide front.

This initial period of organization-building for science and technology was marked by a relatively weak or relaxed control and involvement of the CCP in science and technology activities. During these years, the CCP used the "united front" policy to mobilize China's scientists and technologists; they were given considerable autonomy to undertake scientific and technological research. The overall policy was described as one of "utilization, restriction and transformation", but the emphasis clearly was on "utilization". Because of the relatively mild political control and involvement in science and technology, neither was the Party's ideology imposed on scientists and technologists nor was the thinking of scientists and technologists subjected to "restriction and transformation". In keeping with the famous slogan of "Blooming and Contending" (Let a hundred flowers bloom; let a hundred schools of thought contend) it was strongly assumed that for science to flourish, China must apply a policy of letting a variety of ideas express themselves and letting many theories and methods compete with each other.[9] However, it was short-lived spring for China's S&T community. Around 1957, the strategy of economic development began to be radically changed. With that the emphasis shifted to "restriction" and then to "transformation". A great deal of attention began to be paid to ideological remoulding of the scientists and technologists. The object was to produce scientists and technologists who were "red" as well as "expert".

The Great Leap Forward: 1958-1960

At the beginning of this essay, I have already referred to the ambivalent attitude of the Chinese leaders, particularly Mao Zedong, towards the Soviet model of development. The Chinese communists were believing Marxists but they were also nationalists. In any case, they had discovered during their years of collaboration with the Soviet Union even before 1949 that the Soviet communists assigned a higher priority to Soviet national and Party interests than to the needs of "proletarian internationalism". Mao Zedong, Chairman of the CCP, participated in two months of hard negotiations with Joseph Stalin over a "friendship treaty" soon after coming to power. Soviet support to China during the Korean War, the Chinese discovered, was less than open-hearted. During the subsequent period, Soviet expertise reigned supreme in China. This was resented by the Chinese; they had just emerged out of a century of political, military, economic and cultural subjugation.

Above all, conditions in China were very different from those in the Soviet Union. China had very little cultivable land; extensive agriculture was impossible. The PRC started from a very low level of industrialization; so there were no trained work-force to speak of. Moreover, the Chinese Revolution had emerged victorious with the overwhelming support of the Chinese peasantry. The Soviet model had no place for the enthusiasm of the masses whereas Mao was convinced that the peasant masses were the main motive force of revolutionary advance.

Among what are now called Third World countries, the Chinese alone show the profoundest respect for their own scientific and technological traditions. This pride suffered when Soviet specialists began to lay down the law about S&T politics in China. The ideas of Chinese scientists and engineers were ignored or dismissed by Soviet specialists. Proven traditional practices were dismissed as so much "superstition". All this convinced Mao Zedong and some other CCP leaders that a "Chinese way" to development in China had to be found.

The result was the Great Leap Forward movement, a new approach to economic development through mass mobilization and with it the notion that all practical solutions derived by the masses were "scientific". This composite approach aimed at bringing about rapid strides in industrial and agricultural development by massive mobilization of the workers not only for more intensive labour inputs but also for technological innovation. This, however, did not mean abandonment of programmes to develop major, modern industrial complexes; the construction of these also continued with the Soviet aid.[10] Such a "two-legged" approach to economic and technological developments - the "two-legs" being the foreign (modern) processes and methods, and native ones -- was the brain-child of Mao Zedong. He had noted that the Soviet model had been creating a new scientific and technological elite which was keen on doing research for making a name for itself in prestigious projects of science; it was not keen to relate laboratory research to production. Mao's thinking was not shared by the Party and bureaucrats and the scientists themselves. Yet, his prestige as the "Father of the Chinese Revolution" was so high that he could

swing opinion inside the Party in his favour. He managed to overcome the stiffest opposition to his new strategy of development by CCP leaders like Liu Shaoqi and Deng Xiaoping and was able to persuade the CCP to adopt his ideas of economic and technological development at the second session of its Eighth Party Congress in May 1958.

The "two-legged" approach to development - using both modern and traditional methods and employing specialists and the "masses" -- affected all sectors in China, including science and technology. Science was also to "walk on two legs". The "two-legs" -- professional science and mass science -- were to propel Chinese science and technology in a "more, faster, better and more economical manner". In order to bring this about, it was decided to establish a decentralized science network throughout the country to promote R&D for Chinese traditional sciences and technologies. Research institutions were established at all administrative levels throughout China wherever the requisite conditions were available. These research institutions at the county and the sub-county levels were to actively promote mass scientific experimentation. For staffing these institutes, many unschooled worker-peasant "scientists" i.e., those who were known locally as good farmers and craftsmen were recruited; they were also given membership of professional science organizations.

The emphasis on "native" science and technology was a new element. But the other "leg", namely modern science and modern technology was by no means neglected. To bring about better administrative and policy control over, as well as coordination among the expanding decentralised scientific network, the Science Planning Commission was merged with the State Technological Commission in November 1958 to form

the State Scientific and Technological Commission (SSTC).[11] The new Commission (SSTC) governed China's R&D activities upto 1967 when it was replaced by the Science and Education Group under the State Council. The creation of SSTC streamlined China's science policy organization. It was put in charge of all R&D activities in science and technology and made responsible for guiding and coordinating the work of all sectors of science, including work done under the prestigious CAS. As a result of this reorganization, the CAS lost most of its policy-making functions and power in relation to the total system of R&D in China. At the national level, SSTC directed and supervised all scientific activities conducted by the CAS, the various Ministries as well as the Science and Technology Association of China; this Association was formed in September 1958 by merging the National Association for the Dissemination of Scientific and Technological knowledge with the National Federation of Natural Science Societies.[12] At the local level, the SSTC exercised control through the local scientific and technological committees which directed and supervised the work of the branch academies of the CAS and local institutes at provincial and sub-provincial levels.

Scientific and technological research in Chinese universities was also greatly strengthened during the Great Leap Forward period but the changed orientation required research to be linked to production. This was not the simple notion of "applied" research as opposed to "pure" research. The universities and colleges were required to become not only places of education and training but also centres of scientific research and actual production. The existing structure of the universities was not particularly suited for this purpose. Hence a University of Science and Technology, an

institution of an entirely new kind was established in November 1958.[13] An important function of this University was to meet the need for highly trained scientific and technological personnel. Thus, although science activities were organizationally decentralized and "mass science" was actively promoted, support for conventional science and technology activities also increased during the Great Leap Forward period but with actual production of goods as an added component.

Ideological remoulding of scientists and technologists ("transformation") had become an urgent necessity with the changed policy. During the period of the Great Leap Forward and its aftermath, a great deal of attention was given to political indoctrination of the scientists and technologists. The Hundred Flowers Campaign had brought to surface a number of strains and problems in China's scientific community. With the freedom of debate which was encouraged by the Party during the "blooming and contending" campaign, China's scientists had began to voice demands for greater autonomy in the area of scientific activities. But soon such pleas for autonomy were severely denounced by key Party Officials responsibel for science administration as "individualism" and as attempts to restore capitalism. (The campaign, in other areas too, had turned extremely critical of the Party and was questioning the Party's monopoly of power in China.) Scientists were now asked to establish a 'proletarian perspective" which required them to relate their scientific research directly to national needs. They had to sacrifice their "individualism" i.e., working on a subject of interest to themselves and to devote themselves for collective purposes. They were to "serve the people" instead of hankering after "name and fame".[14] The Great Leap Forward years were thus

marked by a greater stress on "transformation" rather than simply on "utilization" and "restriction" as was the case in the earliest period.

The phenomenon of the Great Leap Forward was characterized by competing approaches to R&D. On the one hand, the conventional approach to R&D, strongly patterned after the Soviet model but with heavier stress on application for production was continued and strengthened. On the other, local level science and technology activities conducted by the workers and peasants were also encouraged and organized in a big way. In both the sectors, modern and native, the principle of the unity of theory was to be used to promote production and the practice of production was to modify theory. In the "native" sector, practice was to be "summed up" in the form of tentative theories and these were to be reapplied to improve production.

In the realm of pure science, scientists were asked to take "dialectical materialism" as their guide and to abandon the "idealist" notions of "bourgeois science". They had to become "red" as well as "expert".

China's science establishment did not take too kindly to the Party's attempts at their "transformation". The bureaucratization of the science establishment through the creation of the SSTC had already given rise to considerable conflict between those who had imbibed professional values (the scientists and engineers) and those seeking to impose ideological constraints (Party officials in charge of science administration). China's scientists has been trained in a tradition which held that scientific theories were independent of any ideology. They had internalized a professional ethos which stressed the importance of autonomy in work and the primacy of expertise in scientific matters. They were

now required to submit to an ideologically oriented bureaucraticization of Chinese science. The concept of "mass science" did not make any sense to them; it served only as an additional irritant to their professional ethos. The Party's attempts to institutionalize the ideological prescription by including unschooled industrial workers and peasants in the membership of professional science organizations clearly struck at the heart of the ethos of professionalism.[15] It was only during the subsequent period of "readjustment" when harsh attempts to institutionalize the ideological approach were abandoned that an accommodation between the professional values and the Party's requirements began to emerge.

Years of "Readjustment": 1961-1965

The Great Leap Forward strategy, it turned out, was too impulsively undertaken. The policies which it sought to implement were untested. The enthusiasm of the Party cadres far outpaced the capacity of the masses to bring about the "leap". The strategy created disorder and confusion of massive proportions throughout China. Things worsened as China suffered a series of natural calamities during the years 1959-60. The misfortunes were further compounded when the Soviet Union suddenly withdrew all its aid to China in 1960; this was a punishment for Mao's defiance of the Soviet ideological and political "line" and the Soviet model of development. The failure of the Leap policies, the natural calamaties and Soviet aid-withdrawal brought to the surface the dissent which had been simmering inside the CCP as well as in the bureaucracy and

S&T circles. Already, at the Lushan Party Plenum in 1959, Marshal Peng Dehuai had launched a frontal attack on Mao's new strategy. Mao survived the attack but had to withdraw from day-to-day policy-making since Peng's views, he realized, were shared by many prominent Party leaders. As a result, the decision-making functions devolved to his opponents like Liu Shaoqi and Deng Xiaoping who set into motion major policy readjustments and almost abandoned the Great Leap Forward Strategy in 1960. Mao remained in the background upto 1964 and then launched his counter-attack. Because of these structural readjustments, priorities and orientations of the science and technology policy also underwent a radical change. It was during this period of "readjustment" that R&D in science and technology in the conventional mould took a firm root in China. It was in many ways a return to the policies of the pre-Great Leap Forward period but without any Soviet aid whatsoever. In fact, the Soviet Union was now actively hostile to China.

The new orientation, however, did not lead to any major organizational change in the conventional research sector of China's science and technology system. By way of "consolidation" the branch academies of the CAS were established but the basic structure of the science system remained unchanged. Instead of further reorganization, emphasis was put on creating a better professional environment which was conducive to research. The aim was to make the system work smoothly. So administrative regulations for research organizations were revised to ensure sufficient autonomy to professional research. Considerable emphasis was placed on guaranteeing at least five-sixth of a week to the scientists for academic work (rather than

on political meetings and mass-science activities) and on providing them with the necessary material facilities for research.[16] A major policy document entitled "14-Point Opinion on Scientific Research" was formulated in 1961. A National Conference on Science and Technology Work was also held in Guangzhou in 1962. All these measures enabled China's science and technology activities to get back on the professional track. The scientists and engineers, in fact, professionals in all sectors in China, were happy. But Mao and the "radicals" inside the Party were not. According to recent reports, these measures were villified by the now-denounced "Gang of Four".[17] Their voice, however, seems to have been feeble inside the Party. The tide had turned. Beginning in 1961, a major shift away from the policies of the Great Leap Forward began to take place.

The post-Great Leap shift of emphasis was reflected in the entirely new Ten-Year Science Plan (1963-1972) which replaced the old Twelve-Year Science Plan (1956-1967). Details of the new plan are also not available but it appears that the planners went back to the original framework of Twelve-Year Science Plan which the Great Leap strategy had abandoned, adapted parts of it and extended the completion date to 1972. Such a revision of the Twelve-Year Plan was obviously necessitated by the difficulties encountered during the Great Leap Forward period and the withdrawal of Soviet scientific and technological personnel in 1960. The adaptation resulted in "shortening the front" of R&D in science and technology.[18] During the Great Leap Forward, R&D programmes had been initiated in many fields on a broad front. Now these programmes were forced to be narrowed to a few vital

and strategic fields, such as agriculture and nuclear development. The failures of the Leap and the resulting famine conditions all over China necessitated an intensification of agriculturally related research. The importance of basic and theoretical research also began to be clearly recognized because the withdrawal of Soviet experts and aid made the Chinese realize that development of science and technology was not possible without nurturing the basic sciences. But it turned out that despite the broad support among the scientists and technicians this new Ten-Year Science Plan also could not be implemented. Later reports blamed "interference" and "sabotage" by the "Gang of Four" for this.[19] This is another way of saying that the followers of Mao Zedong's Great Leap policies continued to successfully oppose the changes brought about by Liu Shaoqi and Deng Xiaoping. Their success can probably be attributed to the fact that the Great Leap Forward policies, despite their actual failure, had inspired sizable sections of the workers and peasants and particularly the young people.

With the abandonment of the Great Leap Forward policies, scientists regained their pre-eminence in scientific matters. The government and Party bureaucracy began to listen to their opinions in matters concerning scientific and technological planning and management. It was a return to the policy of free debate of the type that took place in 1957. Such freedom resulted in somewhat open and widespread discussion in the Chinese press on the correct ways of conducting scientific experiments and of finding effective ways of linking research with production. The scientists strongly argued that the enterprise of modern science and technology was needed

highly specialized scientific management personnel to administer it to ensure rapid growth of science and technology.[20] Thus, S&T management operations and development planning once again reverted to scientists and engineers. Ideological remoulding campaigns were almost totally abandoned. The few "political study" sessions which were held became rituals. The emphasis, in the formula "utilization-restriction-transformation" shifted back to "utilization"; "restriction" and "transformation" of the scientists was pushed into the background.

The larger and near-autonomous role for scientists and other specialists, however, did not mean the relaxation of overall Party control in the science and technology sector. On the contrary; Party participation and control over the organization of science and technology activities and Party guidance in the matter of national goals to be attained remained even greater than during the previous period. But unlike in the Great Leap years when the Party sought to ideologically mould the scientists, it now wanted to ensure scientific advancement and economic construction.[21]

Thus, during this period of "readjustment" the quality of R&D according to internationally recognized criteria of excellence became a major concern. Promotion of ideological values among the scientists and engineers was subordinated to the task of gearing them for meeting the national production needs. With the rehabilitation of experts and professionalism, "mass science" campaigns subsided in favour of professionally undertaken R&D. Science and technology policy of China during this period thereby marked a major shift from the mass-mobilization approach of the Great Leap Forward back to the bureaucratic-professional approach that had begun to take

shape in 1957.[22] Party control over science had, as its major goal, the promotion of professional science and economic growth rather than the promotion of "mass science" and and ideologically derived values.

Under this regime, science and technology prospered. Chinese scientists and engineers completed the projects which were abandoned by the Soviet specialists. Great strides were made in the development of nuclear weapons; China was able to explode it first nuclear device in 1964. Chinese biochemists startled the world by chemically synthesizing pig-insulin. Self-sufficiency in the production of weapon-systems was attained. In the area of exploration and production of petroleum, China made spectacular strides. The country appeared to be on the verge of launching itself as a modern economy with a vibrant science and technology to back it. It is at this time that China's Premier Zhou Enlai announced the ambitious goal of the "Four Modernizations".

Chairman Mao Zedong, watching the scene, nursed deep misgivings about the rise of professionalism and elitism which these policies brought in their wake. With the rise of professionalism, the traditional skills of the masses were denigrated as "backward". Under this regime the young were losing their idealism - not in the Marxist sense which Mao would have welcomed but in the sense of giving up lofty ideals. He saw that China was beginning to take the Soviet path under Krushchev - a highly bureaucratized society in which the "masses" had no initiative or say. He saw a clear danger for the Chinese Revolution; it would first turn "revisionist" and then plunge headlong towards capitalism. Mao was not alone in perceiving such fears. A section of the CCP leadership shared his views and they believed that the Chinese "masses" were with them.

Mao decided to strike before it was too late. He first launched the "Four Clean-ups" campaign in 1964 and later in 1966 he launched the Cultural Revolution. As a part of this,"individualism" and "professionalism" in science and technology once again came under attack - this time far more severe and thorough-going than before.

The Cultural Revolution Decade: 1966-1976

The period during which the Cultural Revolution was under way is difficult to determine. It did start in 1966 but like the Great Leap Forward it too seems to have run out of steam in three or four years. Certainly one phase of it came to an end in 1971 with the death of his "successor" Lin Biao. Thereafter, a short period similar to the period of "readjustment" followed. But this was once again overtaken by another intensified version of the Cultural Revolution. The terminal date has been put as 1976 only because Chairman Mao Zedong died in that year and with his death began another period of policy change. The whole decade of 1966 to 1976 is an extremely confusing period of ups and downs. It will take a long time before we can have a clear picture of what actually happened - in contrast to what was proclaimed.

Still, the policy thrust while the Chairman was alive is reasonably clear. He was, as has been said earlier, extremely anxious about the future of the Chinese Revolution. By 1964, he had come to believe that after the liquidation of the old "bourgeoisie", a new "bourgeoisie" was rising in China. What was worse, the "new bourgeoisie" was gaining the upper hand inside the Party at its highest levels. They were the

"capitalist-roaders" led by Liu Shaoqi, Deng Xiaoping, Peng Zhen and a number of high-ranking Party officials. It was essential to struggle against them by taking class-struggle to the Party itself. This counter-attack against the "capitalist-roaders" within the Party eventually took the form of the great upheaval known as the Great Proletarian Cultural Revolution or Cultural Revolution for short. This second Chinese Revolution as it was sometimes called focussed on class-struggle at the super-structure level and on "continuing the revolution under the dictatorship of the proletariat".

Since the ideology of the Cultural Revolution focussed on class struggle between the "proletariat" and the "bourgeoisie" and on exercising an "all-round dictatorship" of the "proletariat" over the "bourgeoisie" in all sectors of the society, it was natural that the science and technology sector, regarded to be a stronghold of the "bourgeoisie", was to be one of its prime objects of attack and reform. Consequently, major reforms were introduced in the institutional arrangements for the administration of science and technology that were in force before the Cultural Revolution. The SSTC, China's highest science organ for the planning and administration of science during the Great Leap Forward and even thereafter, was replaced by a "Science and Education Group" under the State Council. The SSTC was the science system's major casualty, for although the CAS was also organized and reformed, it did survive the onslaughts of the Cultural Revolution; the SSTC did not.[23] This is all the more noteworthy because the SSTC was established during the Great Leap Forward to break the hegemony of elitist science.

It is not so surprising that the Cultural Revolution policies brought about a change in the management system of research institutes under the CAS. The system had become elitist during the period of "readjustment". Under the new dispensation, the system of a research institute being headed by a Director was dispensed with. Important decision-making functions were taken away from the scientists and entrusted to "revolutionary committees", an altogether new body, set up in the CAS and its research institutes. Consisting of "three-in-one" combinations of "revolutionary cadres", workers-technicians, and "progressive intellectuals"; these committees combined the functions of the erstwhile administrative committees, Party committees, and the academic committees. They took control over the content of research as well as other administrative and academic affairs of the research institutes. The inclusion of workers and technicians in the "revolutionary committees" was intended to provide for their participation in the decision-making process in a research institute.[24] Together with "revolutionary cadres" they reduced the scientists to a minority. It is obvious that the scientists resented this encroachment on their power and expertise. This is why the "revolutionary committee" system was severely criticized after the overthrow of the "Gang of Four" for failing to organize and direct scientific research and for their failure to arouse the enthusiasm of scientific and technological personnel. The present Deng Xiaoping regime has now abolished that system and the old system of an institute headed by a scientist-director has been reinstituted.[25]

The Great Proletarian Cultural Revolution was, as its name indicates, a political or ideological upheaval. Naturally, a great deal of attention began to be put on

ideological remoulding of the scientists and the technologists. Accordingly "Mao Zedong Thought Propaganda Teams" made up of worker-peasants and PLA soldiers were dispatched to the institutes to "reeducate" and change "bourgeois" world outlook of the scientists.[26] The attack on elitism and professionalism also resulted in greater emphasis on "mass science" rather than on professional science. The contributions of laymen as the "motive force" for the development of science and technology once again came to the forefront as during the Great Leap Forward. The mass media in China repeatedly reminded the people, particularly the scientists and engineers, that science and technology were created and developed by the "broad masses of the working people" on the basis of their actual practice of production. It was not something invented by the scientists in their laboratories. Since the worker-peasant masses were upheld as the real creators of science and technology, it logically followed that scientists and engineers should be sent to the factory-floor or the countryside for shorter or longer spells to learn from those directly engaged in production. They were exhorted to leave their laboriatories and conduct joint scientific experiments with workers and peasants and learn from the latter's "abundant" practical experience. This was called "going out". Conversely, the participation of workers and peasants in scientific activities in the research institutes was also considered essential; this was called "inviting in". In contrast to the Great Leap Forward policies which only emphasized the participation of workers and peasants in research activities, the Cultural Revolution expanded their involvement to management functions of the institutes as well. It, thus, encouraged the participation of the non-professionals at a higher level in China's science and technology system.

The science and technology policy of the Cultural Revolution period was a total departure from the scientific and technological models imitated by China initially from the West (before 1949), and later from the Soviet Union (during the early 1950s and the early 1960s). An important goal of the CCP after coming to power in 1949 was not only to catch up technologically, industrially and economically with the most developed countries, but also to fulfil the CCP's objective of turning China into an egalitarian and participative society. The Soviet bureaucratic-professional model of science and technology offered the hope that the goal of catching up with advanced science and technology could be achieved. Stalin had shown how this could be done. But some leaders in the CCP, particularly Chairman Mao Zedong and his followers, came to realise that the Soviet model violated other basic goals of Chinese socialism such as mass participation and creativity, and social equality. Western and Soviet science and technology, in Maoist opinion, had led to a social stratification that separated the scientific and technological elite of the laboratories and drawing-rooms from the peasants and workers in fields and factories.[27] They, therefore, propagated the Cultural Revolution policies in science and technology as the correct path for promoting "proletarian science" and revolutionary egalitarianism in China.

This approach to science became one of the key issues in the power-struggle in China in subsequent years. In fact, the Cultural Revolution innovations - there were a very large number of them in other sectors - were never accepted by the Party as a whole. In the eyes of the opponents of the

Cultural Revolution and the scientists and engineers themselves, such innovations (called "new-born things") were hindering China's modernization for all time to come. They beleived that such an ideological orthodoxy was irreconcilable with the imperatives of modern scientific and technological research and China's goal of rapid modernization. When Mao's successor Lin Biao died in 1971, they seized the opportunity and made an attempt to moderate the science policy of the Cultural Revolution. But this attempt only produced an aggressive reassertion of the Cultural Revolution perspective.

With Lin Biao's disappearance in September 1971, a serious discussion about the wisdom of the various science and technology policy reforms introduced during the early phase of the Cultural Revolution began in China. By the beginning of 1972, widespread concern was expressed by some that the expertise of the scientists and the technologists should be given "full play" if China was to modernize rapidly. Scientists were urged to draw up plans to improve the situation. Zhou Peiyuan, Vice-Chairman of the Revolutionary Committee of Beijing University, was personally asked by Premier Zhou Enlai to play a major role in this task in 1972. Professor Zhou thereupon prepared a key article putting forth his views on the subject. He emphasised that the universities must attach enough importance to the study of and research in basic theoretical problems of science.[28] In the light of Zhou's proposals, the Beijing and Qinghua Universities were asked to prepare a draft on the strengthening of basic theories teaching in class-room courses and laboratory research. The universities put forward a

draft entitled "Report on Speeding Training of Scientific Research Personnel and Strengthening Theoretical Research in the Faculties of Sciences" in March 1973.[29] The contents of this document are, however, not available. Several years later, it was disclosed that the Report was "sabotaged" by the "Gang of Four" and the demands put forward in the Report "could not be realized in the main".[30] Clearly, a policy mutually agreed upon by the Maoists as well as the experts towards science and towards technology could not be evolved.

In fact, these attempts at moderation of the science policy of the Cultural Revolution began to be severely attacked by the votaries of the Cultural Revolution in the aftermath of the Tenth Party Congress of the CCP held in August 1973. Eventually, these attacks and other criticisms of the policies which the "modernizers" i.e. Mao's critics', wanted to implement took the form of a movement known as the "anti-Lin, anti-Confucius" campaign. This campaign produced the first major comprehensive theoretical-ideological defence of science policy of the Cultural Revolution in the Chinese media. This may be because the Maoists, by then, had acquired the near-total control over the media. By 1973, they had also provided a comprehensive theory about the development of science and technology in world history.

As far as the war of words was concerned, the Maoists had the upper hand. They not only controlled the media in China but their interpretation of "dialectical materialism" and "historical materialism" also had Mao Zedong's approval. Their control, however, did not extend to the running of science and technology institutions. Thus, while acrimonious attacks went on in Chinese publications, the actual research work going on remained largely unaltered. And, even when

science policy itself was altered at the top, it was not implemented in the research institutes. This gap between policy-pronouncements and work at the laboratory bench needs to be borne in mind in looking at the science and technology scene of this period.[31]

Thus, while the Maoists continued to propagate their views of science and technology, the scientists continued to adhere to and when possible even to strengthen professionalism. What is more they did not give up basic sciences during the years of the Cultural Revolution. Scientia Sinica, the prestigious journal of the Chinese Academy of Sciences reappeared in 1973, having suspenended publication in the years 1966-1972 . According to recent reports, two important directives on the questions of basic scientific research and student enrollement in the science faculties of the universities were also issued in 1974. Following these directives a newly established planning group for the development of basic sciences drew up a "Ten-Year Outline Plan for the Development of Basic Sciences". However, the Maoists reportedly were able to impede its implementation.[32] Party ideologies and scientists were thus locked into an impasse.

Despite the polical turmoil generated by the Cultural Revolution and despite the deadlock in policy-making and implementation, impressive achievements were recorded in many fields of science and technology. By the end of 1974 China had made significant strides in many defence-related fields, e.g., the development of atomic and hydrogen bombs, guided missiles with nuclear warheads, man made earth satellites and certain types of naval vessels as well as in the development of a DJS-130 multi-purpose electronic digital computer, an electronic scanner microscope with high resolving power, a 200,000 kilowatt steam turbo-generator with inner-water

-cooled stator and rotor, and in determining the crystalline structure of biologically active pig insulin. The theory of continental origin of oil and theory of the "straton model" in particle physics may even be said to be original Chinese contributions. In the arena of international scientific collaboration, too, China expanded its relationship with other countries.[33] Beginning in 1972, it resumed scientific cooperation and exchange programmes, suspended during the initial years of the Cultural Revolution, in a big way despite the vehement rejection of "bourgeois" professional science in the Chinese mass media.

It is, therefore, doubtful whether the policies of the Cultural Revolution really had the detrimental effect on science and technology which is now attributed to them in the barrage of criticism against the Maoists, now dubbed as the "Gang of Four". But, there is little doubt that there were serious differences within the highest Chinese leadership over policies towards science, technology and education. Advanced science and technology and higher education, all categorized as elite preserves did not receive high priority support since the beginning of the Cultural Revolution. Professionalism in science and technology was under severe attack. Long-term explicit planning in science and education had come to an end. The Maoists thought that this was a small price to pay for the sake of a brighter revolutionary future. The opponents of Mao and the professional scientists and experts feared that science, technology and other sectors of the economy in China were falling farther and farther behind those of other industrialised countries. In their opinion immediate and radical

reforms in science and education were necessary if China was to modernize and rapidly catch up with the industrialized countries. Then came a shift in the balance of power in their favour at the Fourth National People's Congress in 1975 and they sought to reverse the science and technology policies of the Cultural Revolution. But once again they were frustrated by yet another aggressive reassertion of the science policy of the Cultural Revolution by the Maoists or the "Gang of Four".

The Fourth National People's Congress (NPC) was held in January 1975. It was the first such meeting to be convened in a decade. The session approved a very ambitious long-term programme for China's modernization; it called for ten-year as well as five-year Planning and even set broad goals for the reminder of the present century. The two-stage long-term modernization programme called for building an "independent and relatively comprehensive industrial and economic system" before 1980, and to accomplish "the comprehensive modernization of agriculture, industry, national defence, and science and technology" ("the Four Modernizations") so as to put China's economy "in the first ranks of the world" by the end of the present century.[34] The NPC not only approved this very ambitious programme of "the Four Modernizations" but also appointed to the State Council, China's Council of Ministers, a team by and large consisting of opponents of the Cultural Revolution. The chief among them was Deng Xiaoping, their most vocal representative and also the most vehement critic of the votaries of the Cultural Revolution. This sudden change, apparently engineered by the late Premier Zhou Enlai, created apprehensions in the members of the "Gang

of Four" that the new policies were aimed at negating politics and class-struggle which was their stock in trade. During the 22 months following the NPC meeting till the downfall of the "Gang" in October 1976, an intense struggle over ideology and politics took place in China and issues dealing with science and technology policy were central to that leadership conflict. The Maoists or the "Gang" put up the fiercest defense of the Cultural Revolution policies in science and education as well as of those in other sectors of China's economy through a series of nationwide ideological campaigns to exercise an "all-round dictatorship" in the superstructure, including all spheres of Culture.

While the national media continued to reverberate with revolutionary thunder, Deng Xiaoping, who was brought back from the wilderness and put in charge of the State Council in the absence of the ailing Premier Zhou Enlai, began taking concrete measures to implement the programme of "the Four Modernizations" almost immediately after the NPC meeting. He had convened an enlarged meeting of the Military Affairs Commission of the CCP in July 1975 which discussed the basic tasks ahead for the modernization of China's national defence. Deng Xiaoping then convened a national conference on the Dazhai experience in agriculture in September-October 1975; the Dazhai agricultural "brigade" was upheld by the Maoists as the most shining example of revolutionary agricultural development. Deng Xiaoping and his supporters wanted to demolish it in favour of scientific modernization.

Under Deng's instructions, three important programmatic documents were also drafted to push forward the economy. The most important of these dealt with general problems and the overall approach to governing China. Entitled On the General

Programme for All Work of the Party and the Country, it paid ritual obesciance to Mao by taking his "three directives" (On Studying the Theory of the Proletarian Dictatorship and Combating and Preventing Revisionism; On Promoting Stability and Unity; and the Directive on Pushing the National Economy Forward) as the general plan for all work over the next 25 years. A respectful bow to Mao Zedong's doctrine was essential in order not to arouse opposition. But then Deng proceeded to place great emphasis on economic development. The document called for "rectification" -- i.e. leadership reorganization, policy changes, etc -- in industry, agriculture, transport and communications, finance and trade, science and technology, culture, education and public health, literature and art, the Army, and the Party.' Describing Mao's "three directives" as "interrelated" and "inseparable", it argued for taking all three of them as "the key link". Deng Xiaoping thereby devalued the priority Mao Zedong and the "Gang" had given to only one i.e., "class struggle as the key link".[35]

Deng Xiaoping's second important document bore the title Some Problems on the Acceleration of Industrial Development. Also known as the Twenty Articles on Industry, it laid out a wide range of measures to make China's economy surge forward towards the goal of "modernization". Some of these were: strengthening industrial management, defining spheres of responsibility to ensure rapid economic development, grade-promotion of industrial workers, and raising technical skills of the workers. It argued for the need of importing the most advanced technology from abroad to accelerate the speed of China's modernization programme and

specified certain measures to be adopted on the import of technology.[36]

The third important document concerned the modernization of science and technology. Since modernization of the other three areas -- agriculture, industry, and national defence -- was conceived of as being closely intertwined with and dependent on modernization of the science and technology sector, Deng Xiaoping made this sector the prime object of reform. A document entitled Several Problems Concerning Scientific and Technical Work, also known as Outline Report on the Work of the Academy of Sciences (the Outline Report in short) was prepared under his direction to bring about the modernization of this sector. The Outline Report was intended to achieve in science and technology what the Twenty Articles on Industry were to accomplish in industry. It spoke of a "crisis" in Chinese science and called for reorganization of the CAS and reforms in the management system of the research institutes. It also dwelt on the relationship of science and technology on one hand and production on the other, the role of professionals and masses in scientific research and on international scientific collaboration.[38]

Since the Cultural Revolution, the size of the CAS had been considerably reduced through the outright closure or the transfer of many institutes from the CAS's jurisdiction. Many CAS institutes had been either put under the joint jurisdiction of the CAS and the local (i.e. provincial and municipal) governments or were transferred to the sole jurisdiction of the local governments. The Outline Report, therefore, strongly argued for building up new research

institutes and putting them under the direct leadership of the CAS. It also argued for reorienting the work of the CAS institutes towards basic research.

The most important reform formulated in the Outline Report concerned the management of research institutes. In contrast to the "revolutionary committee" format management system of research institutes introduced during the Cultural Revolution, the formula prescribed a return to the more conventional system of management, utilization of research and higher education in vogue before the Cultural Revolution. The Outline Report asked Party leaders in charge of research and educational institutions to acknowledge their limitations in the matter of scientific and technological expertise and to give those with a high level of professional knowledge greater say in decision-making in the leading bodies of the CAS and its institutes. It argued for appointing eminent scientists as Directors of research institutes; the Party Committee secretaries and logistics personnel were to serve only as adjuncts to them. It was pointed out that this was the correct approach to institute management which was followed by all advanced countries in the world irrespective of their political systems[38] (author's emphasis).

This particular section of the Outline Report produced the severest denunciation the votaries of the Cultural Revolution had made of the counter-policies in the realm of science and technology. The Maoists accused Deng Xiaoping and his supporters of attempting to stir up a "vocational typhoon", to put "bourgeois politics" in command of scientific and technical work and to "negate" the leadership of

politics over vocational work. This, it was argued, would "liquidate" the achievements of the Cultural Revolution and enable the "bourgeoisie" to exercise dictatorship over the proletariat in science and technology. The Maoists, therefore, fiercely campaigned for retaining the "revolutionary committee" form of management system of research institutes and for involving ordinary workers and peasants in the decision-making structure of the research institutes. This, they hoped, would end the "monopoly" of scientific research in the hands of only a few people and gear it better to "serve the masses".

Besides emphasizing reorganization and reforming the management system of the research institutes of the CAS, the Outline Report also elaborated on the "correct" relationship between scientific research and production. It did acknowledge the classical Marxist position that science originated from production. But it went on to argue that science and technology did not lie in the realm of the "superstructure"; they were productive forces in the "base" which must go in advance of production and push production forward. This called for strengthening basic scientific research work. The Outline Report, therefore, strongly emphasized theoretical research in the natural sciences to fulfil the task of catching up with and surpassing the advanced world levels of science and technology. Accordingly, it called upon the CAS to actively undertake certain major and comprehensive scientific and technological research projects in industry (mineral prospecting, materials - science, automation, and remote control), agriculture (agricultural mechanization, developing new types of seeds, prevention and control of plant diseases and insects, weather prediction, etc.), medicine and public health (acupuncture anaesthesia, family planning etc.) and

defence construction (research and development of new materials and advanced defence equipment) to fulfil the needs of the national economy and defence construction. It proposed opening up a number of newly emerging areas of science and technology e.g. satellite launching and satellite monitoring, information theory and cybernetics, development of new sources of energy, bionics, etc.'

The Outline Report further called upon the CAS to develop basic research in many fields of science. The fields emphasized were mathematics, astronomy, mechanics, physics, chemistry biology, oceanography, and the earth sciences in general, and elementary particles, quantum chemistry, cosmogony, the origin of the cell, genetics, etc., in particular.[39] The Outline Report, thus, formulated a very ambitious programme to bring China at par with advanced world levels in various levels of science and technology by the end of this century. Such emphasis on basic research also became an important target of attack by the votaries of the Cultural Revolution policies. Their argument was that the pursuit of basic sciences or "pure science" would lead to the pursuit of "science for science's sake" and create an elite strata of scientists divorced from the problems of everyday Chinese life. Diverting the resources towards basic research, in their view, would result in squandering huge amounts of state money for developing theories which might not be directly and immediately applicable to the concrete current needs of China.

Since, in Deng Xiaoping's scheme science was to move ahead of production and research on basic theories was to be strengthened, it logically followed that professional scientists should become the backbone of scientific research. The Outline Report, therefore, strongly argued for bringing

into "full play" the role of professionals in scientific research. As a gesture to Mao Zedong who was then still alive, the document provided that science was still to walk on the "two legs" of professional science and "mass science". But, there was to be a strict division of labour between the professionals and the "Mass Contigents" in science and technology. Scientific research was indeed to be integrated with production practice in factories and rural areas. But not all scientific research activities were to be conducted in this manner. In no way, argued the Outline Report, was scientific work for which experiments and study could not be performed at the sites of production but only in a laboratory to be negated and abandoned. Thus, the policy of conducting scientific research in an "open-door" way was not to be followed indiscriminately.[40]

The Outline Report reminded the policy-makers that there was a wide gap between the level of China's science and technology and that of other industrialized countries. It, therefore, prescribed a policy of absorbing the "good experience" and "good science and technology" of foreign countries, capitalist or socialist, and put them to China's use. It also argued for improving and strengthening China's participation in scientific and technically oriented activities with foreign countries.[41] The Marxists looked upon this prospect with horror; for them such "blind faith" in the science and technology of the "bourgeoisie" in foreign countries was bound to turn China into a "dependency of imperialism and social-imperialism", the euphemisms used for the United States and the Soviet Union respectively.

Deng Xiaoping's package programme of these three important programmatic documents - On the General Programme for All Work of the Party and the Country, Some Problems On the

Acceleration of Industrial Development, and the Outline Report on the Work of the Academy of Sciences -- sought to alter beyond recognition almost all the Cultural Revolution innovations in the areas of science and technology, higher education, and industrial management. This offended the policy convictions of the "Gang of Four" and posed a mortal challenge to their political position. These documents shook Chinese politics from late 1975 till the death of Mao Zedong; they were severely denounced as the "three poisonous weeds" of Deng Xiaoping - in contrast to the revolutionary "flowers" being nursed by the Maoists or the "Gang of Four".[42]

The Outline Report was summed up as a "blueprint of the "revisionist line" in science and technology in the Chinese mass media then controlled by the "Gang of Four". The attacks on the Outline Report made a strong plea for defending and developing the innovations of the Cultural Revolution. The most important of these innovations was the system of "open-door" scientific research in which scientists and technologists were to be "integrated" with industrial workers and peasants; either the latter were "invited in" to do research in the institutes or the former were "sent out" into production settings. This meant that research in the laboratories by scientists was to be linked with experiments and production practice by the workers and the peasants themselves. Such integration of research and production was to be brought about by doing scientific research in "three-in-one combinations" firstly of workers-peasants, cadres, and scientific-technical personnel, and secondly of research-, production-, and user-units through the methods of "going out" and inviting in". Under the scheme of "going out", scientists and technologists in the research and academic institutes were to conduct research on problems encountered in production together with workers, peasants and other laymen at the site of production.

"Inviting in" meant admitting outstanding workers, peasants and other laymen to research institutes to conduct research in conjunction with the scientists and technologists. This also involved encouraging the workers within the research institutes to participate in research and management. In the view of Deng Xiaoping, this system was retarding China's modernization for all time to come. The Outline Report, therefore, prescribed a policy of bringing into "full play" the role of professionals in China's science system. Thus, whether or not to conduct scientific research in an "open-door" way became another key issue in the debate about science and technology in 1976.[43]

The last phase of the Cultural Revolution (1975-76) was characterized by formulation of Deng Xiaoping's package programme for China's modernization and the Maoists' severe condemnation of it. However, towards the beginning of November 1976, the tide turned. Mao Zedong had not been only mortally ill during the most of 1976 prior to his death in September, he had also developed deep reservations about the "Gang of Four". The tone of the Chinese press changed dramatically when discussing issues of science and technology policy, and the "Gang of Four" began to be denounced for "sabotaging" the interests of China's science and technology. Surveying the entire Cultural Revolution scene, it may be questioned whether the policies of the "Gang of Four" really had the impact on the scientific research establishments as is made out in the criticism against them.[44] But it is true that it was only after the downfall of the "Gang of Four" that Deng Xiaoping's new programme could be endorsed by the Central Committee of the CPC. If the "Gang" could not implement its own science and technology policies, it would at leas

stall those of Deng Xiaoping while Mao Zedong was still alive. But with his death in September 1976, the balance of power shifted against the Maoists. This resulted in major changes in all sectors of the society in China including science and technology.

The Post-1976 Scenario

The death of Mao Zedong did not immediately produce a victory for Deng Xiaoping and his supporters. At Mao's death Deng was still in political exile having been driven there by the "Gang" immediately after Zhou Enlai's death early in 1976. Mao's death was followed by a palace coup in which the four members of the "Gang" and their supporters were arrested. This enabled Deng Xiaoping to make a gradual come-back. Although Hua Guofeng, Mao's successor, vowed to continue the policies of the Cultural Revolution, he was gradually eased out by Deng Xiaoping who finally emerged as the supreme leader in China.

Under Deng Xiaoping's leadership China has launched new policies on scientific research, higher education and international scientific relations to realize the "Four Modernizations" in industry, agriculture, science and technology, and national defence. Modernization of science and technology has thus acquired a high priority in the new development strategy; it is being viewed as "the key" to the modernization of the other three areas. A series of institutional reforms affecting the organization and administration of science and technology have been initiated.

The latest changes in science and technology policy place heavy emphasis on strengthening and revitalizing the professional component of China's science system. The new

orientation, however, has not led to any significant organizational changes in the structure of the science system established before the Cultural Revolution. Although many new research institutes have been established in the past few years and those closed down during the Cultural Revolution have been reopened, the basic edifice of China's science and technology system is quite similar to that which existed in the immediate pre-Cultural Revolution period. Instead of further reorganization, the new regime has opted to re-establish and reactivate the science organizations and to re-institute the administrative regulations that existed in the immediate pre-Cultural Revolution years. The State Science and Technology Commission (SSTC), a major casualty of China's science establishment during the Cultural Revolution, was re-established in 1977 and has one again become the leading organ for overall planning, coordination, organization and administration of scientific and technological work. Similarly the Science and Technology Association formed in 1958, made defunct during the Cultural Revolution, was revived and renamed as the China Association for Science and Technology in March 1980. It has resumed its activities and the professional societies under it have once again become very active in fostering development of science and technology along professional lines.

With the re-establishment of the State Scientific and Technological Commission, systematic and explicit long-term national planning in science and technology has been re-introduced. At the National Science Conference held in Beijing in March 1978, an Eight-Year National Science Plan entitled "Outline National Plan for the Development of Science and Technology, 1978-85" was announced. It set forth the following goals to be striven for by 1985: to

"increase the number of specialised scientific research workers to 800,000"; to "build a number of modern centres for scientific experimentation"; and to "establish a nation-wide system of scientific and technological research". The Plan makes "overall arrangements" for research work in 27 areas, including natural resources, agriculture, industry, national defence, transportation and communications, oceanography, environmental protection, medicine, finance and trade, culture and education, in addition to the basic and technical sciences. Within these 27 areas, 108 "key projects" of scientific and technological research have been identified; the details of these, however, have not been disclosed. There are eight priority areas mentioned in the new Plan, namely agriculture, energy resources, materials, electronic computers, lasers, space science and technology, high-energy physics, and genetic engineering. The Plan also provides for establishing a comprehensive national scientific and technology research system with "complete disciplines, mutual adaptation, proper disposition and coordinated development which integrates defence research with civilian research". It was expected that with the fulfilment of this Plan in 1985, China would "approach or reach the advanced world levels of the 1970s in a number of important branches of science and technology", thus "narrowing the gap to about ten years" and "laying a solid foundation for catching up with or surpassing advanced world levels" in all branches of science and technology in the following 15 years.[45] However, in the years following the National Science Conference, there have been important modifications in China's economic strategy. These economic readjustments probably have also affected the science and technology Plan.[46] As this essay is being written (1984), we do not know how far the Plan has been implemented during the seven out of

its eight years' time-frame.

Besides re-establishing and re-instituting the science policy and implementing the structures and procedures of the pre-Cultural Revolution period, the present regime of Deng Xiaoping has been creating a "better professional environment" conducive to research and making the system respond rapidly to the goals of the modernization programme. Administrative regulations for research institutes have been revised and scientific and technical personnel have been guaranteed a minimum of five-sixth of the weekly working hours for professional work. Another important characteristic of the new science and technology policy is that the research institutes have been asked to work with what is known as "an appropriate division of labour". In other words, a distinction is being made between those institutes which are to concentrate on "basic" research and those that are to be mainly oriented towards applied research. In line with this policy, "basic" research has been assigned mainly the institutes of the CAS. This approach is in sharp contrast to the policies of the Cultural Revolution which emphasized applied research in all institutes, including all institutes of the CAS. As a result of this renewed emphasis on "basic" research in the CAS, control of many institutes transfered to the local governments during the Cultural Revolution has reverted back to the CAS. The same principle of "appropriate division of labour" is also applied to the work of the research institutes under the various ministeries.

The changed higher education policy of the present regime has promoted science and technology research in the universities as well. The universities are now required to serve as "both educational centres and scientific

research centres"; until now they had concentrated on teaching. Many universities, including the University of Science and Technology, have set up "advanced scientific bases" for basic research. The need for an integration of teaching and research has been stressed by citing the examples of such western universities as Stanford, Gottingen, and Cambridge where advanced training and research are intimately related. Combining scientific research with teaching, it is being emphasized, would not only improve the quality of research and the professional level of the teachers themselves but also help to incorporate advanced scientific research accomplishments into the teaching syllabi and thus raise the quality of science and technology education. Of the 108 "key" scientific projects in the Eight-Year Science Plan, universities and colleges have been assigned as many as 76 projects.[47]

To achieve the objectives of the Eight-Year National Science Plan, major changes in the institutional setting for science and technology have been introduced. The Party's policy towards scientific and technological personnel has undergone a radical change. Far from being called the "stinking ninth category of people's enemies", an epithet they had been given during the Cultural Revolution, intellectuals, including scientists and technologists,are now held in high esteem and are regarded as indispensable to China's modernization programme. There is a strong emphasis on improving logistical and other support work and to provide the scientists with better working conditions. The system of giving awards and prizes for meritorious work has also been reinstituted. The salaries of scientists and technologists are still low and their housing conditions are still far from satisfactory. But the Chinese govern-

ment has announced its intention to remedy this soon.

In the new, somewhat liberalized political environment, the scientists have regained their pre-eminence in scientific matters. The "revolutionary committee" system of management which fused the functions of academic planning, general administration, and political work during the Cultural Revolution has been totally abandoned and replaced by the pre-Cultural Revolution administrative system of research institutes headed by Directors who are responsible to the Ministries in the government and the Party committees in their institutes. Academic committees within the research institutes have been reinstituted to give scientists greater power to decide academic matters. Although the principle of Party leadership in the research institutes is still upheld, there is now a strict "division of labour" between the role of the scientists and that of the Party Committee in the management of the institute. The Party Committee deals with matters of policy and principles, while the scientists-director of the institute has full responsibility over professional affairs. His/her main functions are to ensure that the infrastructure of the research institute works well and that research does produce result. The vesting of responsibility in the hands of the professionals indicates a level of confidence in this group not seen in China ever before. It is, thus, not a simple return to the pre-Cultural Revolution policies but a step forward towards professionalization of science and technology and a step away from its "revolutionization".

The rehabilitation of expertise has also led to a radically different interpretation of the "practice-theory-practice" principle of epistemology than the one propounded during the Cultural Revolution. This is reflected in statements defending the "relative independence" of theory in

development and the ability of theory to predict and even guide practice. Scientific and technological work is, therefore, required to "precede" production; and for science to "precede" and "guide" production, theoretical knowledge must be created through scientific experimentation. The new science policy, therefore, places heavy emphasis on "basic" scientific research. Despite all this, however, the Chinese leaders continue to adhere to a very utilitariam view of science and the scientists. The new policy emphasizes, as before, that research – no matter how "basic" in character — cannot be research for its own sake; it must lead to production, the sooner the better.

What then of "mass science"? Here, too, old ideas die hard. Or perhaps, it has been found difficult to completely take away what has once been given to the masses. Whatever may be the reason, the new Chinese leaders, despite their preference for professional science and specialized education, also support "mass science experimentation" activities. But now the principle of "an appropriate division of labour" has been extended to mass science programmes. So, the professionals and the non-professionals engaged in any scientific activity are asked to work in the framework of "appropriate division of labour". This means that in low-level, mundane work-a-day areas of science and technology, the "research" work— it may amount to no more than quality control or selection of better seeds — is done by and together with the non-professionals, while research in highly sophisticated fields is left to the professionals alone. In industry, worker-made innovations are still encouraged but they must be approved by professional experts before being adopted.

The developments over the past few years suggest that the debate over various issues of China science and technology

policy is still on and optimum solutions for integrating scientific research with the production needs of the national economy have not yet been found. The need for the scientists to become more involved in the nation's practical problems and to give priority to improving productivity in agriculture and industry is being constantly stressed. It appears that in their rapid ascent in the years since the end of the Cultural Revolution, scientists engaged in basic and theoretical research and engineers working in high-technology fields have tended to be elitist and isolated and one can discern some disillusionment on the part of the national policy-makers with the attitudes and demands of the scientific community.[48] The Chinese media has admitted that the principle that "science and technology work must be geared to the needs of economic construction" has not been sufficiently imbibed by scientists and engineers. Scientists are being constantly exhorted to appreciate the importance of linking their research to needs of the economy.[49]

With this end in view, a high-level "Science and Technology Leading Group" directly under the State Council was established in January 1983. Headed by Premier Zhao Ziyang himself, this new Group is composed of leaders from the State Planning Commission, the State Scientific and Technological Commission, the Commission in charge of Science, Technology and Industry for National Defence, the Chinese Academy of Sciences, the Ministry of Education, and the Ministry of Labour and Personnel. The function of the Group is to provide "unified leadership" over economic planning, R & D planning, and science and technology manpower training and allocation. These functions had been previously the responsibility of the State Scientific and

Technological Commission (SSTC) alone. But now the high level of composition of the Group shows the priority China's leaders attach to the contribution of science and technology to national economic development.[50]

Science and technology policy in post-Mao China has clearly taken the road already being followed by most of the industrially advanced countries of the West. This amounts to an unprecedented policy change in the life of the People's Republic of China. The original goal of "utilization, restriction and transformation" of the scientists and technologists is now nowhere in sight. The much desired combination of "the red and the expert" is not even mentioned any more. And it is not as if the clock has been turned back to the "utilization" principle; that was meant for the scientists and technologists inherited from the "bourgeois" society. Now the new generation of scientists and technologists being nurtured in "socialist China" are also of the same mould. And what is more, the concept of "restriction and transformation" has disappeared. "Mass science", the innovative parallel stream of the past, now flows as an extremely weak current.

What fascinates many students of China, such as this author, is the uniqueness of the Chinese civilization. In the past, this civilization produced its own science and its own technology. Then came the introduction of modern science and technology of the West to China. For a time, it looked as if modern science and technology would completely replace the Chinese inheritance in the field of science and technology. However, the Chinese Marxism of Mao Zedong began

an experiment in the field of science and technology, as in many other fields of human activity, to produce a synthesis. It was a heroic attempt to produce a "paradigm shift". It won many adherents not only in the Chinese Communist Party but among the scientists and technologists as well. But with Mao Zedong's disappearance from the Chinese scene that unique experiment seems to have come to an end.

It is too early to write a final epitaph on that experiment. As has been said at the beginning of this essay, Chinese scientists and technologists continue to show an extremely lively interest in their Chinese inheritance. The Chinese people as a whole have always asserted their attachment to their "native essence" (guocui) whenever their country has begun to look like a shadow of an alien model. Above all, the Party ideologues and the scientists and technologists who supported the S & T policies launched by Mao Zedong are very much on the scene; they may be down but they are not out. And they are young. It is not Deng Xiaoping but the next generation of leaders in China which will decide whether there will be anything uniquely Chinese about science and technology in Twenty-first century China.

FOOTNOTES

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