previously made door handles. In the interval since 1971 production has ranged up to ten computers of the same design per year. But in the same period great advances have been made in the United States and a U.S. computer costing a hundredth as much as the Chinese version can accomplish the same calculations at similar speed. The computer is not the best model the Chinese have produced, and the factory cited is not their most efficient one. However, the contrast in cost illustrates a problem that China will face when it engages in international competition.

If the Chinese are to compete in many of the items of international trade, they must bring to the undertaking more than cheap labor, patriotism, and self-discipline. Improving their capabilities in science and technology will help, but alone they will not be enough. Once truly committed to modernization, the Chinese may find themselves facing no end of changes, pressures, and social problems.

But the Chinese are an intelligent, energetic, and moral people. They have come far in the last 30 years. They will continue the development process. It is even possible that in spite of shifts in policies and direction that at times are destructive and self-defeating, they may yet arrive at a better, more livable social structure than others have thus far achieved.

References

1. The following trip reports of the Committee on Scholarly Communication with the People's Republic of China have been published by the National Academy of Sciences, Washington, D.C.: A. FitzGerald and C. P. Slichter, Eds., *Solid State Physics in China* (1976); American Insect Control Delegation, *Insect Control in the People's Republic of China* (1977); American Plant Studies Delegation, *Plant Studies in the People's Republic of China* (1975); *Oral Contraceptives and Steroid Chemistry in the People's Republic of China* (1977); and *Astronomy in China* (1979). Other articles include "Earthquake research in China," *Eos* **56**, 838 (1975); (education and science) E. Signer and A. W. Galston, *Science* **175**, 15 (1972); (earth science) E. C. T. Chao, *ibid.* **179**, 961 (1973); (computer technology) T. E. Cheatham, Jr., *et al.*, *ibid.* **182**, 134 (1973); (scholarly exchanges) H. Brown, *ibid.* **183**, 52 (1974); (agriculture) G. F. Sprague, *ibid.* **188**, 549 (1975). For an extensive listing of publications up to 1976, see Congressional Research Service, *Annotated Bibliography on Science and Technology in China* (Government Printing Office, Washington, D.C., 1976).

The Chinese Scene

William D. Carey

Coming from Tokyo, the contrast on arrival at Peking could not be sharper. Peking is the fabled Xanadu, pleasure dome of Kubla Khan. But today very little pleasure is visible. The city is proletarian in all its features. The population fills the sidewalks, streets, and avenues: on foot, on bicycles, stacked in buses and open trucks. Rush hour sees streams of bicycles flowing, crowds queuing at bus stops, patiently and without shoving or pushing. There is a universal atmosphere of organized existence. There are no beggars, few loungers. Dress is simple, colorless, and drab, but clean. Facial expressions range from deadpan to the glowing joy of teenagers. This is by no means a sullen people. They eye Americans with curiosity and often with smiles and a stray word or phrase of English.

The AAAS group saw no signs of teenage hoodlumism. The bicycle brigades swept down the avenues in good order, the crowds on the streets were well-behaved, and the mornings dawned with the sight of hordes of young people running through the streets singing and exercising on the way to school. No police sirens ever sounded, day or night, and uniformed police were hard to find. On the other hand, who was a policeman? When we were taken to see the Forbidden City or the Summer Palace, we noticed that as the proletariat crowded around us and listened to our guides, other proletarian-looking men would suddenly step forward and send them packing. And no back talk or sullen looks. The only sign of behavioral independence was jaywalking into the traffic stream or driving a bicycle or truck across the bows of a madly honking official car.

Work and Leisure

Although the populace appears to be in a constant state of motion, coming and going to nameless destinations on nameless errands in a permanent rhythm of organized futility, one senses beneath it all an explosive energy and power, a human machine in the process of being shaped, directed, controlled, and harnessed.

China is a nation of toilers. On any journey, short or long, one sees laborers at work, on farms or on the roads. Their work is backbreaking and powered largely by human muscle. A new road is laid by pick and shovel, with an ancient coal-burning steamroller waiting to smooth out and pack the stones. In the fields, water buffalo pull wooden plows steered by the peasants. Women do everything that men do, with no relief from the hardest kind of labor. A common sight from the window of the luxurious official limousine (the "Red Flag") is long lines of handcarts loaded with bricks, pulled by women between the shafts and pushed by others at the rear, bent almost horizontal. At the foreign visitors' hotels, guests' bags are hauled up to the rooms by teen-age girls who do not seem to mind at all. Hundreds of millions of people are doing these things 6 days a week, taking a short break only to spoon a bowl of rice, vegetables, and bits of fish or meat. Nobody looks hungry or inadequately clothed.

On Sunday, Heroes' Square is dense with silent and orderly regiments of people waiting by the hour to enter the massive mausoleum of Chairman Mao and glimpse the body as it lies in state with an honor guard of soldiers armed with bayonets. Once back in the streets, they pack the sidewalks and the shops, crowd around the ice-cream vendors, and stand 30 or 40 deep, reading the wall posters. They find pleasure in books, radio, museums, the arts, and the movies. Although they follow the Marxist line and emphasize pragmatism and realism, they turn to fantasy for entertainment. We were treated to movies and an operetta, all of which featured romantic fables out of the long ago, with lovers separated and then rejoined by the interventions of good fairies, bad fairies, magic, and dragons. The singing was haunting and the dancing exquisite, but the plots would not meet a Western standard of realism. But the cinemas are crowded and the people cannot get enough of them despite the poor quality

Family group in Peking. [Photo by William D. Carey]

of the films, which were made more than 20 years ago. China is about to organize a film production industry from scratch, and it will be interesting to see what it comes up with. We saw a current documentary film of the reborn Music Conservatory in which a dozen young artists aged 8 to 15 demonstrated extraordinary musical proficiency and concentration, and the technical quality of the film was equal to anything New York could produce.

Another strong impression of China today came out of our visit to a "key" middle school in Shanghai and a kindergarten in Kweilin. The middle school provides 3 years at the junior high level and 2 years of high school, and the school we were shown was obviously one of their best. It had 1600 students and 120 teachers. The courses covered literature, mathematics, chemistry, physics, foreign languages, biology, geography, music, Chinese history, and physical education. The aim of the school, we were told, is to raise the all-around development of the students on the moral, intellectual, and physical levels. Political education deals with the revolutionary idea and the approach of Communism. The teachers must keep up their studies of Marx, Lenin, and Mao's thought, and both teachers and students are sent out to the countryside to learn labor from the peasants.

In the first classroom, an English language class, as we entered there was total silence. Sixty teenagers were sitting with their eyes closed, listening to a rhythmic chant from a tape recorder. Then the pitch changed, and all 60 pupils began to massage the upper bridge of their noses with thumb and index finger. Again the pitch changed, and the pupils (still with eyes closed and no one cheating to glimpse the Americans lined up along the walls) began massaging the eye muscles. A third change of pitch, and 60 heads dropped in unison onto folded arms. The tape stopped, and all eyes focused on the teacher. We learned that we had walked in on a "relaxation period" and that all the massaging was to relieve eye tension and prevent nearsightedness. This is a notion of Chinese medicine, and is related to acupuncture. The eerie aspect was the total concentration of the students, even in relaxation, and their self-control in avoiding distractions. We stayed for English and algebra sessions, and the performance was superb. Despite a dreadful street racket of honking trucks and traffic, to say nothing of 20 staring Americans, neither teachers nor students missed a beat. Later, we met with the faculty and two students, a boy and a girl. When we asked the girl what her ambition was (she was a science major), the answer came back, "to fulfill the four modernizations" (industry, agriculture, defense, and science and technology). Asked what they knew about America, for a moment they were stumped. "Very little," said the girl. "Nothing," said the boy. But after some fast thinking, the girl said, "Americans are friends of China, and they are very clever."

The kindergarten at Kweilin was an eye-opener. There were several hundred children aged 3 to 6. They are taken at the age of 3, to relieve working parents, and for 6 days each week they live, eat, learn, play, and sleep at the school. On the seventh day they go home to their parents. The children were beautiful, clean, and exquisitely trained. Babies performed acrobatics for us, danced, and recited "poems of Chairman Mao." The teachers were dedicated and very good with the children, who seemed to enjoy what they were doing. We went through the dormitories: 36 little beds in each, immaculate and without a wrinkle, clothes stacked in neat piles on shelves, and a bed in the corner for the teacher. The entire kindergarten operation seemed to follow a script, with the youngsters and the routines thoroughly programmed. Not a child cried, not one seemed distracted by the foreign visitors, nothing was out of place. The environment was one of total control, total order, and precision. We had to marvel at it; but more than one of us felt that it was as chilling as it was efficient.

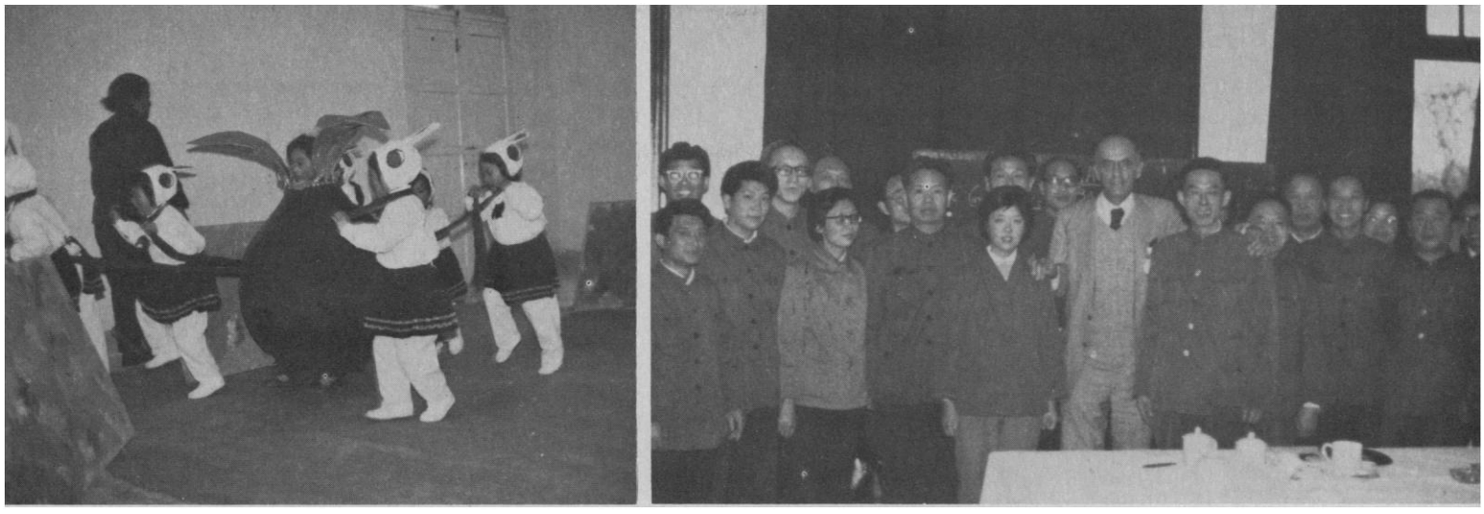
Scholars and Scientists

The happiest people we found in China were the educated class who had studied in the United States in the 1940's and 1950's, before the Cultural Revolution. Their delight in being liberated was plain to see, and the alumni and alumnae from Berkeley, Harvard, MIT, Michigan, Columbia, Wisconsin, Yale, and Smith were radiant at the prospects for reunion with American colleagues. Most of them bore the wounds of the last 10 years, although they were discreet about their experiences. They have been recalled to fill key positions in the research institutes and universities, and without exception their minds are on the future instead of the past. Their resilience says a good deal about the Chinese capacity to absorb punishment and survive.

Our principal exposure was to these scholars, scientists, and interpreters as well as the leading officials. They were uniformly gracious, considerate almost to a fault, friendly, and likable. One had a strong sense (or illusion) of making fast friends. They recited the errors of the Gang of Four to the point of tedium, but not once was there criticism of the mistakes or excesses of Americans. They were discreet. They spoke repeatedly of their backwardness, but they made plain their intention not only of catching up but of "overtaking" us—a more polite term than the Soviet threat to bury us. As for the Russians, the bitterness of the Chinese toward them is never concealed. They blame the Russians almost as much as the Gang of Four.

Visiting their research institutes was a revealing experience. The buildings typically were run-down and without amenities. It was standard procedure to be greeted on the front steps by the institute head and his staff, bundled in hats and coats; go inside and climb several flights to a meeting room where tea and cigarettes were laid out; and conduct the exchange still wearing coats while our hands gradually froze. Heat (this was late November) was not programmed for some weeks to come. The same situation existed as we were shown laboratories, where the scientists briefed us in poorly lit rooms, wearing Mao caps and heavy clothing. In a word, the setting was Spartan. But the mood was something very different: upbeat, serious, confident, proud of what could be done under adversity.

They are frank in admitting backwardness, and direct in asking for any help or knowledge that we can share. They had no embarrassment in letting us see the poverty and austerity of their working environments. They could not have cared less. One had to like them, wish them luck, and want to help them. What we saw was the price China has paid for decades of the self-reliance theme. It has



(Left) Kindergarten in Kweilin. (Right) Group present at a lecture at the Chinese Scientific and Technical Association. Peking, by William D. Carey (center). [Photos from William D. Carey]

put them in a bad way, and it is no wonder that now the line includes a higher proportion of foreign reliance than of self-reliance.

The generally ruinous state of scientific research and technology in China was plain to see. Propaganda aside, there can be no doubt that science was savaged from the mid-1960's to the mid-1970's and is reemerging from a dark age. All the blame for this is heaped upon the Gang of Four. When questioned as to how this could be possible, the answers are that because the Cultural Revolution was cloaked in twisted interpretations of Chairman Mao's principles, even the intellectuals were confused to the point of "not knowing what was right from wrong." But this answer was not universal, as we found in south China from an aging but dynamic scientist who declared that she fought back and continued teaching and research all through the period, even making her students learn English and follow the English language scientific literature. Yet she was the exception. The others were bitter, but apparently had seen no way except to conform and wait it out. When we asked where Chou En-lai was during all this, the reply was that he recognized the errors but had to go very slowly in correcting them. Nobody pointed a finger at Chairman Mao himself. Indeed, at every briefing, the Chinese took care to say that China is now following the line laid down by Chairman Mao. Supposedly, they were attributing the rise of the Cultural Revolution to Mao's own prophecy that the socialist road would be beset by "contradictions." So there it is, a puzzle for the Western-trained mind. But we remember the stories of book burning, bombing, and arson at universities and the killing of faculty members of the Peking Conservatory of Music. Perhaps the most likely explanation for the overthrow of the Gang of Four was the one we heard near the end of the trip, that with the suppression of farmers' private plots and the prohibition against raising hens and chickens, the standards of living and income fell so far that the lid on the discontent finally blew off.

The goals of the four modernizations will be difficult to fulfull in the absence of a vast infusion of technical assistance from the outside and the creation, starting from almost zero, of exceptional capabilities from the inside. The risks for science are those that are typical for a developing country: massive preference for fast technological and industrial leaps and pressure for quick results from applied science. This means that higher education paired with scientific research will be promoted, but that modernization of laboratories and research institutes could come more slowly. If this view is more or less correct, it puts a double emphasis on the importance to Chinese science of student exchange with advanced countries, importation of Western experts for extended lecture tours, and getting foreign scientific literature to restock the libraries. Along with this, the Chinese must expand their foreign language instruction; it is noticeable that in the university libraries English language books are covered with dust and some have not been checked out for years.

But there is another obvious problem for the Chinese in forcing the pace of modernization. They do not yet seem to realize that as they approach a level of scale in industrialization and press for technological innovation and export markets, they will require skills in management. Even a socialist economy needs first-rate managers as it progresses toward development. Few Chinese leaders with whom we talked had any appreciation of this until we narrowed the lines of discussion to the problem of quality control. Then they came alive and said that it is one of their worst problems and that in some plants, such as textile factories, failures in quality control are penalized by taking the loss out of the pay of the managers. But there is not yet enough recognition that training in middle and upper management is a priority on which the four modernizations will depend. No central institute appears to be in existence for this purpose, and nobody seemed to know whether Chinese would be sent abroad to Western centers of management training and education. This was a point that the AAAS group raised repeatedly during the visit.

It is also clear that the gradual improvement of productivity through farm mechanization, improved fertilizers, and insect control programs will free millions from the communes and create social problems. Ths Chinese answer to this is that the workers will be absorbed by the parallel growth of light and heavy industry, transportation, and education. In short, an expanding economy will solve structural employment problems and, through a policy of industrial decentralization, keep the masses from crowding into the cities.

Because science education is crucial to China's modernization goals, the Board asked to meet with the Ministry of Education in Peking, even though the Chinese did not have it on our itinerary. This turned out to be a revealing meeting with the Vice Minister and several of his deputies. It began, as usual, with a speech about the four modernizations, but soon the point was made that science and technology are the keys, and education provides the foundation for all of it. If the four modernizations are to happen, China must train as many skilled people as possible and very quickly. China can buy technology abroad, but skills must be developed at home.

The Vice Minister went on to say that the problem is not simply to increase the number of students. It is to quickly improve the quality of education. The plans are to (i) get the 400 existing colleges and universities to absorb more students; (ii) open new colleges and universities, together with 2-year vocational or professional colleges; and (iii) develop television and correspondence courses along with "July 21st schools" for workers at the factories, to teach trades.

The goal for higher education is to increase the college and university student population from under 900,000 to 3 million by 1985, even though this is far too little for a country with China's population. But the question of how to increase the number of teachers and improve their skills is a hard one. As of now, they are taking their best graduate students and preparing them for college teaching. On top of this, they have to raise the skills of the existing teachers, and they do it by running all-day courses taught by competent professors. Short courses are being given in locations where capable faculty are concentrated. Veteran teachers of good quality have the job of rapidly training new ones. And under the program to send "students" overseas for training, nearly half of those sent will be teachers in the next 2- or 3-year period. At the same time, China wants to bring in teachers from abroad—specialists and scholars who will give lectures on either a short-term or long-term basis. While all this is going on, China will have to modernize laboratories and bring in "machine literacy."

Questioned about the condition of libraries, the Vice Minister described them as badly damaged. Almost nothing was published during the Cultural Revolution, and little was allowed in from abroad. A conference was held in 1978 to evaluate textbooks to be introduced into China. Considering that there are about 20 "important" universities in the world (for instance, Massachusetts Institute of Technology, Harvard, Oxford, Cambridge, Tokyo, and Moscow), the Chinese want the textbooks they use and are beginning to bring them in. The Vice Minister added the hope that AAAS would help to provide textbooks and publications in science and technology, along with tapes, slides, and other aids to accompany the textbooks. When asked whether the Ministry has a translation capability, the answer was a brief "yes." The next question was on the foreign language training program, and this time a long answer was given. It turns out that this is a major bottleneck, again because of the Gang of Four. China realizes that language training is crucial, and besides English, which is being taught in many schools, they are launching programs to train people in French, Japanese, German, Spanish, and other languages. Students are asked to start foreign languages in the primary schools. Besides foreign language departments in the universities, there are a number of language institutes in Peking, Shanghai, Canton, and elsewhere. Foreign languages are also taught on television and radio.

AAAS and the Chinese Scientific and Technical Association shook hands on a flexible agreement to develop good mutual working relationships. A Chinese delegation will make a return visit for 3 weeks to AAAS in the spring. AAAS is sending *Science* magazine to a dozen or so centers in China. We are going to share other AAAS publications and symposium books with them, and make them welcome at our meetings. There has already been a significant exchange of books and documents between their Academy of Medicine and our National Library of Medicine, as a direct result of our trip. The Chinese have asked us to contact a long list of U.S. experts whom they wish to invite to give lectures for extended periods in China, and they want to develop a specific exchange with AAAS in the field of popularization of science and technology. Although it is not spelled out in the agreement, the prospects are also good for joint work related to strengthening science education, and for a substantial collaboration aimed at scaling up Chinese scholarship in the social sciences. Since our main purpose was to lay the cornerstone for increasing communication between the respective scientific communities through nongovernmental channels, that objective was accomplished.

China: Objectives, Contradictions, and Social Currents

E. E. David, Jr.

In Peking, the weather is chilly; there is ice on the ponds in the mornings and winter is coming. But there is the air of spring among scientists, teachers, and intellectuals. There is celebration at their release from the suppression of doctrine and dogma. Science and technology, and specialized advanced education, are now looked on as essential resources for national development, rather than as evils to be condemned and suppressed. Contacts between Chinese scientists and engineers and those outside are now encouraged. Universities are planning 100 percent or more expansion; admissions on merit rather than political acceptability have been restored. Graduate education will be resumed on a large scale. New research equipment has begun to arrive from the West, and research institutions are being similarly treated. Students will be sent abroad in large numbers and exchanges are contemplated. It is enough to gladden the heart of any partisan of science.

There is no doubt that these movements are genuine, as is the opening of China to importation of foreign technology and to joint enterprise with Western firms. Indeed, the promise is great, and the enthusiasms of those who see the rapid emergence of China as a world power based on its 1 billion people are understandable. Actually, I detected an element of euphoria both in Peking and among returning travelers. A sober assessment raises a number of doubts.

I think back to the time in 1972 when President Nixon and Dr. Kissinger returned triumphant from their visit to China. At the subsequent Cabinet briefing, President Nixon expressed his admiration for the Chinese leadership—Chou En-lai and Chairman Mao himself—and for their consistency and logic in their conduct of foreign policy. He also expressed awe at the intrinsic power of a