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.

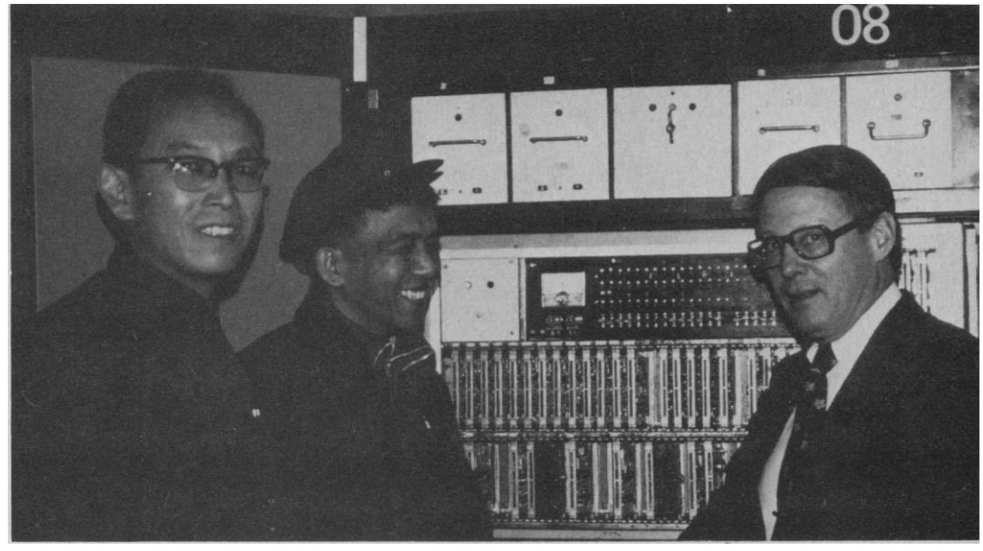
In Peking, the weather is chilly; there is ice on the ponds in the mornings and winter is coming. But there is the air of spring among scientists, teachers, and intellectuals. There is celebration at their release from the suppression of doctrine and dogma. Science and technology, and specialized advanced 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

nation consisting of one-quarter of the world's population. But what was their view of us? The President was clear on that point. They admired our accomplishments, but they questioned our resolve. They wondered if we could establish a foreign policy and have the will to sustain it to the point of effect. Perhaps the Chinese leadership is still waiting for its answer. But now we can raise the same question about their situation: how stable is it, how permanent is the turnaround, how far is it likely to go? Are they moving too fast, away from their revolutionary past and toward more conventional ideas for development of Chinese society? What social movements will be generated by the change from Chairman Mao's continuing revolution to stability and the building of institutions and elites? What will be the reaction to the removal of long-standing societal symbols, the "little red book" and Chairman Mao himself as the omnipotent leader?

Of course, there are no firm answers to such questions. But the questions themselves suggest the uncertainty in the picture. Kenneth Boulding has said that "events are not as significant as you think." Indeed, there is a large measure of randomness and happenstance in affairs. Events are not often the result of an explicit plan, carefully thought out and precisely executed. Events in China arise probably out of a mélange of influences in an unplanned way. Of one thing we can be sure: there are still elements in China that would prefer the traditional Maoist course to a Western-inspired modernization of their society. Despite such obvious sources of uncertainty, there do seem to be some fundamentals in the situation that make it more predictable than the questions above would indicate.



Chinese computer scientists with E. E. David, Jr. [Photo from E. E. David, Jr.]

AAAS Visit

Perceiving those fundamentals and examining them in some detail were among the purposes of the recent visit by the AAAS Board to China. I doubt that we can add much that is new to the picture already available in sober quarters here. But the breadth of the delegation, covering engineering and the physical, life, medical, and social sciences as well as politics, was extraordinary. The congeniality of the group allowed a scholarly synthesis of comprehensive ideas. Many of these we shared and discussed with our Chinese hosts. We talked intimately with Chou Pei-yuan, president of Peking University and of the Chinese Scientific and Technical Association. We compared notes with Vice Premier Fang Yi, now also acting head of their Academy of Sciences.

Our Chinese hosts were very open in these discussions, and we were also, as soon as we became accustomed to the idea of a freewheeling exchange of views in a regimented society. I suspect that this relaxed interaction was possible because we were a nongovernmental organization without any official sanction or standing. The only times of tension occurred when someone on the Chinese side recognized that some of our delegates were government officials (such as Congressman Mike McCormack) and took the opportunity to lecture us on the necessity for normalization of relations. (The visit occurred before normalization was achieved.) The trip was largely privately financed and sponsored, although of course we kept the State Department informed, and we met with Ambassador Leonard Woodcock, head of our liaison office in Peking. Thus, we were free to speak our minds in Peking, and now in Washington and elsewhere.

Despite these advantages, I hasten to deny any special insights or expertise in the Chinese situation, which is immensely complex as Chinese scholars well know. Indeed, it is difficult to organize one's thoughts after returning from the ferment that is China today. One important feature of the scene there is contradiction. For example, the Chinese are wary of the Soviets. They are actively opposed to the Soviet government and its way. They are concerned about the aggressive Soviet foreign policy. The Chinese have little sympathy for the Soviet Union's adventurism or its accomplishments in science. Yet the Chinese organization of research is in the Soviet pattern. Research institutes are a part of the Academia Sinica. University research is under the Ministry of Education, while industrial research and development is carried out in industry itself. This fragmentation makes it difficult to integrate research and development efforts effectively, just as it is in the Soviet system.

Another contradiction is that Chinese science and technology are furthest advanced in areas of their least need. One physician put it well—he said, "We tend to emphasize the sensational; re-attaching severed arms and fingers when what we need most is an effective public health program." One of China's stated priorities is high-energy physics, hardly a technology of the people, and we saw good work in the synthesis of graded refraction optical fibers for information transmission where there is a clearly inadequate voice telephone service. Such paradoxes are not unique to China, of course. But the contradictory elements seem a significant part of their overall system.

Objectives for National Development

Still another instance involving contradiction stems from their stated objectives for national development and for science and technology as part of their vision of the future. These objectives were adopted and promulgated as national policy in well-publicized meetings held earlier this year in Peking. There, four modernizations were established as goals: agriculture, national defense, industrial production, and science and technology—the last being essential to the first three. A later conference defined eight priority science and technology subjects ranging from agriculture through energy and materials to genetic

Poster in Peking. The writing says "Our friends are all over the world." [Photo by William Wight]

engineering, computers, space science, lasers, and high-energy physics.

These choices show a certain sophistication, ranging as they do from the essential, agriculture, through development necessities to prestige fields aimed at rehabilitating their science and joining the international club. But these choices are coupled to very ambitious time scales. The Chinese aspire to attaining the level of late-1970's Western technology by 1985, and being "thoroughly modernized" by the end of the century. Yet there is little obvious planning, organization, or management aimed at achieving those goals. For example, in rebuilding their research and education, they are reinforcing the existing structure of institutes, educational activities, and industrial research separated by bureaucratic barriers. This structure is of Soviet origin, and now would seem to be a unique opportunity to change it to a more unitary system to encourage transfer of knowledge and technique from research to production. They may be missing a chance to make their innovation system much more effective by organizing it to remove the barriers so obvious in Soviet-style systems. Little thought has apparently been given to this possibility.

Clearly, modern planning and organization are difficult in a society that for almost 30 years has depended for achievement on collective resolve and the thoroughly puritanical little red book, and that has only a small cohort of technocrats as responsible managers. I was particularly taken with one question that was repeatedly asked: "Dr. David, how will we know when we have achieved a technologically advanced society? What are the indicators?" The question itself is poignant and does credit to the Chinese intellect, but it indicates the lack of well-defined goals.

Social science in China is highly underdeveloped. As members of their Academy of Social Sciences pointed out, they do not have the fields of sociology and anthropology yet. Social science there tends to encompass history, literature, and political science. The move toward a technologically advanced society will raise new social questions for China. For example, rapid development of technologically based industry will create an elite of scientists, engineers, and managers. Yet that is contrary to the Maoist ideology on which their society has been based since 1949. The new road is a drastic change and will have far-reaching social effects. What will be the internal reaction to encouragement of entrepreneurial tendencies after they have been suppressed for so long?* Traditionally the Chinese have been shrewd businessmen, but have 30 years of Maoism changed that? Overall, I believe there has been little thinking about the detailed effects of indigenous innovation and modernization on their society.

We found knowledgeable and sophisticated people in all of the research institutions we visited, many of them trained in the United States in the 1930's and 1940's and in Europe later. Yet there was little appreciation of what it takes to establish a computer industry, for example. We found no pressure for clean rooms in manufacturing, user education, or evangelism to turn computer skeptics to enthusiasts among the users, and of course marketing is a foreign concept. At the computer factory we visited, the development group showed that these ideas were not beyond their thinking, but are beyond the action stage at present. They do have plans to set up an equipment maintenance organization now that they have been making machines since 1973. The plant and its workers formerly made doorknobs and handles, so their present output represents quite a conversion.

Another contradiction is apparent in the grand marble mausoleum in Tienamen Square that holds the body of Chairman Mao. We visited the mausoleum and saw him lying in state. That structure and its contents are a monument that cannot be erased. Recall that the Soviets removed Stalin from the Red Square mausoleum when they repudiated him, but they had Lenin to fall back on. There is no such parallel in China (although one wonders about Chou En-lai). Yet there is clearly an ongoing attempt to repudiate Mao and Maoism as a rigid doctrine—and more importantly, as a guiding operational philosophy. That process is behind the posters, demonstrations, and statements in Peking, and does indeed seem to be a prerequisite to technologically based development. After all, one cannot learn to build computers from reading the little red book.

We found a strong attachment in Peking to Marxist economics. In many institutions and in the main square one sees posters of Marx, Engels, Lenin, Stalin, Mao, and Hua. Yet there are evidences of pragmatism in practice. The recent legitimization of joint ventures with Western enterprises is a particularly striking example.

I could go on with this list of contradictions. Another one is the ready availability of news from the foreign press in Peking. Printed in English, it is not in newspaper form but is given as a duplicated handout to foreigners every day. I found no drive to acquire these handouts among our Chinese intellectual friends, whereas there is a demand for any foreign news publication in Moscow. There seems to be less suppression of factual news in Peking, yet there is certainly not full freedom of opinion, despite the rather effective Chinese technique of using posters to express ideas.

Contradiction in practice is perhaps an important feature of Chinese style—a yin-yang effect much more compatible with the Chinese mind than with our own. Having duly noted this element of strangeness, let me go on to other elements. You will note some level of contradiction in all these matters as well.

I was fascinated by the central role of rhetoric in China. Rhetoric is a political tool in many countries, but the uniformity of theme in China is striking. We heard denunciations of the Gang of Four for past abuses from almost everyone. Their removal from power is said to be the most significant political event since the 1949 revolution. The Gang of Four and Lin Piao are clearly the current domestic villains, and they are blamed for the excesses of the Cultural Revolution and the suppression of modern development. It has been said that radical move-

*Actually, there are signs that entrepreneurship survives in China. Along the back streets of Shanghai we saw small shops producing goods such as metallic washers, woven scarfs, specialty foods, and reed furniture. At least some of the output is sold on the spot. It is hard to believe that a part of this commerce is not outside the system.

ments thrive when some devil has been identified for condemnation. The Gang of Four certainly fills that role admirably and perhaps they will soon be joined by Chairman Mao, although I doubt his repudiation will go that far, given the Chinese respect for the past and their need for traditions. Who or what will be the next target? It will be well for adventurous enterprises and nations approaching China to be wary.

Economic and Political Prospects

There has been much enthusiastic comment here and in Europe about China's future role on the world scene as an economic power. It has been said that what China chooses to do, she can do. Actually, the picture is much hazier. China's industry is not modern, and productivity has not become a major economic objective. Where technology enters the picture, it is an empirical technology. For example, there is labor-intensive production of circuit breakers and steam turbines. Those products seem adequate for immediate needs. In one plant producing trucks the output is around 400 per day, again labor-intensive. Mass production with automated equipment is yet to appear, although it is clearly an objective in China's drive for industrial modernization. The implications of an industrial modernization policy go beyond the mere increase in gross Chinese product. Socialist societies traditionally are in need of labor; everyone works since the system demands it. China has the world's largest work force to accommodate. What will happen when industrial development reduces job availability? What will be the social impact of job elimination in a society where it seems against both doctrine and tradition? I believe that little thought has been given to such puzzles—after all, there are no sociologists to raise the issue. The paradox of a highly productive energy- and capital-intensive industry in a traditionally labor-intensive society will raise problems.

If China is to follow the path toward modernization, financing is a key question. We were told that there are ample reserves of hard currency for immediate projects. China has accumulated substantial currency reserves from its exports to Japan, and of course there has been no corresponding drain on its accounts. But to sustain the long march toward modernization, new sources of wealth will be required. One possible source frequently cited is oil. Currently identified Chinese oil reserves amount to perhaps 20 billion barrels—somewhat less than U.S. reserves. More important, the potential is largely unknown. Contrary to many stories, there is no indication that China will become oil-rich. There are interesting prospects for new fields offshore, but they are yet to be explored. Nevertheless, financing is not likely to be a limitation in the near future for Chinese development. Available credit seems to be more than adequate for the near term.

On the international scene, there are very strong long-term forces pushing China and the United States together. Perhaps the strongest lies in the international political-military realm. It is no secret that the United States and other Western nations do not feel able to parry Soviet thrusts in all parts of the world. The Chinese have said that the Soviet Union is the most imperialistic factor on the world scene. Regardless of the truth of that statement, China and the United States have a profound mutual interest in seeing that the Soviets do not dominate the Western Pacific and Southeast Asia. The Soviet moves toward Vietnam seem sinister. Thus, as one looks some years down the road, there are likely to be reasons for the United States and China (along with Japan) to consider an alliance, formal or informal. Will we see the sale of U.S. military hardware to China? Will we see the U.S. fleet in Shanghai harbor? It is not impossible, and so the United States clearly has a stake in the success of the Chinese efforts toward modernization.

Western Contributions

So far I have noted some of the contradictory elements in the Chinese situation, the paucity of management planning to reach ambitious goals, the sociological uncertainties raised by the trend to reject Maoism as an operational doctrine and to move toward a society that is more energy- and capital-intensive than labor-intensive, and finally the long-term forces pushing China and the United States together. If we try to assist China, what sorts of contributions should we consider? Certainly the Chinese will require modern technology and financing. But they will also need aid in management, planning, elements of marketing, and science and education. No matter what we do, there are likely to be steps forward, backward, and sideways as China proceeds along its chosen path.

We may worry that China will have problems such as we see in Iran today. In Iran, foreign influences brought in by the government have led to strife involving both traditional religious and modern liberal factions. Still another worry is the language problem. I am told that Chinese is a difficult language for precise communication such as that required in science and engineering. The many dialects in China present a difficulty too. It remains to be seen just how serious the difficulties of communication and documentation will be.

As we prepare to aid China, we must ask what the character of Chinese technology and products is likely to be 25 years hence, around the year 2000. Much of the technology we saw still shows the influence of China's earlier Soviet connection; automobiles, petroleum refineries, radios, and electrical equipment are examples. Looking ahead, however, perhaps our best clues come from Chinese art. The style of a nation's technology often seems akin to its artistic style; perhaps the connection is through engineering and manufacturing design. Chinese art of certain earlier eras was elegant and simple. However, the modern art we saw is not as fresh or graceful. Judging by that, we would not expect Chinese technology to have the simplicity or functionality of Japanese technology, the originality of U.S. products, or the ponderous character of Soviet design. Perhaps the Chinese will create their own style in the manner of the French, but to do so they will have to exhibit more originality than is evident today. I doubt, therefore, that indigenous Chinese products will be strong competitors on the international market soon. At least for a substantial time, the Chinese will compete in the fashion of South Korea, Taiwan, or Singapore, which use imported technology and principally foreign designs.

So I return from China with mixed feelings. One cannot help but admire and respond positively to the smiling scientists and engineers one meets there. One is startled by the ambitious plans for modernization but dubious about their execution. One sees the common interests of China and the United States, but is concerned that a Chinese course can be held long enough to achieve common objectives. Beyond all this, however, there is no doubt that we have witnessed over the past 6 years a major change on the world scene—the opening of China to the West. The dimensions of the change are not yet fully apparent. As they emerge, we will find that there are new fundamentals. It is significant that the Chinese place science and technology in the forefront of these.