China Faces the Future

"Hands off!" warns an imperial lion that stands guard in the Forbidden City, but China's policy of self-reliance does not exclude "a little help from our friends"

BY ROBERT J. TROTTER

"The man-eating society" that devoured the lives of millions of Chinese people during 4,000 years of slavery, feudalism, imperial neglect, civil warfare, foreign invasion, famine and disease appears, at least temporarily, to have been satiated. Peace and order have come to China allowing for a population of nearly one billion to be adequately fed, clothed and employed. The government of The People's Republic of China, which celebrated its 30th birthday this month, is justifiably proud of what has been accomplished and has set an ambitious goal for the future — the complete modernization and industrialization of China by the year 2000. In an effort to accomplish this awesome task, the Chinese have made an enormous investment of time, money and human energy in science and technology and have brought about what is being called a "springtime for science" in China.

Spring, however, comes after more than a decade of discontent. During the Cultural Revolution of the 1960s and under the influence of the Gang of Four in the early 1970s, science and scientists were frozen out. The emphasis was on a revolutionary attitude to the exclusion of all else. The educational system and research establishment suffered ten years of complete disruption, with students being admitted to university on political rather than academic grounds and scientists being taken away from their research and sent to work in the countryside. One professor at Beijing University told us she lived in terror of the Red Guards and didn't know when she woke up whether she would live through the day. But those days are gone.

The spring thaw for science came in March of 1978 when 6,000 scientists convened in Beijing to set science policy goals for the future. Vice Premier Fang Yi, the official in charge of science and technology for the PRC, admitted at the time that China had lost ground and was 15 to 20 years or even farther behind the rest of the world in many branches of science. But he predicted that when the current 8-year plan (1978 to 1985) is fulfilled "our country will approach or reach the advanced world levels of the seventies 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 in the following 15 years."

Will science blossom and bear fruit in the healthy climate that now prevails, or are the Chinese expecting too much of their still-fragile system? Fang remains optimistic. He told us that the plan is proceeding on schedule and that although a few minor adjustments may have to be made most goals set for the turn of the century should be met.

Some of Fang's optimism stems from the realization that China currently enjoys a place in the sun — internationally speaking. On friendly terms with much of the industrialized world, China is busily setting up scientific communication systems and scholarly exchange programs in an attempt to learn from and possibly avoid the mistakes of others. China can sit back and make critical decisions about which of the available technologies are most likely to survive transplantation to Chinese soil.

"China is backward, compared with the West and Japan," admits Fang, but he goes

Blackboard on a factory wall sings the praises of modern science and technology.

on to say "it is not a loss of face to admit this backwardness...we want to catch up." China's obvious thirst for scientific know-how and equipment, for instance, probably played a role in the recent normalization of relations between the United States and China. "As I myself am in charge of science and technology," said Fang, "I don't think I should overestimate its worth in the normalization, but I certainly believe that this consideration played a role in providing an impetus to the normalization."

"Pine Greeting the Guests": Fang Yi (front row center) poses in Great Hall of the People with delegation of science writers from the United States.

PRC

In return for what China can get, there are certain things that China can give. Historically speaking, says Fang, China has made great contributions to human progress (paper, gunpowder, printing and the compass were invented in China) and will continue to do so. He cites archaeology, seismology and Chinese medicine and pharmacology as well as a vast expanse and enormous abundance of natural resources, including oil, titanium, vanadium and tungsten. "All of these," he says, "are open for joint study and research."

During our tour of Chinese scientific institutes, hospitals, universities and factories we heard more about joint research, scientific exchanges and China's potential contributions, but judging from what we saw it is clear that China is involved in another very long march. The lack of modern scientific technology is one indication. China is producing some of the equipment it needs, including computers, but scientists at several facilities complained about how difficult it is to do up-to-date research with out-of-date equipment. They mentioned specifically the U.S. State Department's embargo on the exportation of sophisticated computer technology to China.

Technology, however, can be imported or copied eventually, but using that technology is a different matter. A simple accounting of qualified scientific personnel provides another good indication of just how long China's march will be. The Chinese claim to have a force of 300,000 trained scientists and technicians and hope to raise that number to 800,000 or one million by the end of this century. The United States, with a population approximately one-fifth that of China, has nearly ten times as many trained persons working in science — 1,375,000 scientists and 1,331,000 engineers — according to the National Science Foundation's most recent (1976) figures.

But we saw more than China's self-proclaimed backwardness. We saw a government and a society apparently dedicated to the idea of progress through science. China's much-mentioned Four Modernizations program focuses on agriculture, industry and defense but puts a special emphasis on science. The symbols of modern science and technology are highly visible in both urban and rural areas, in factories, on farms and on communes. Wall posters, billboards, banners, slogans, numerous popular periodicals and television all promote science. Given several decades of peace, political stability and economic prosperity (none of which is assured), today's springtime for science, may make tomorrow's China bloom and keep the man-eating society at bay.

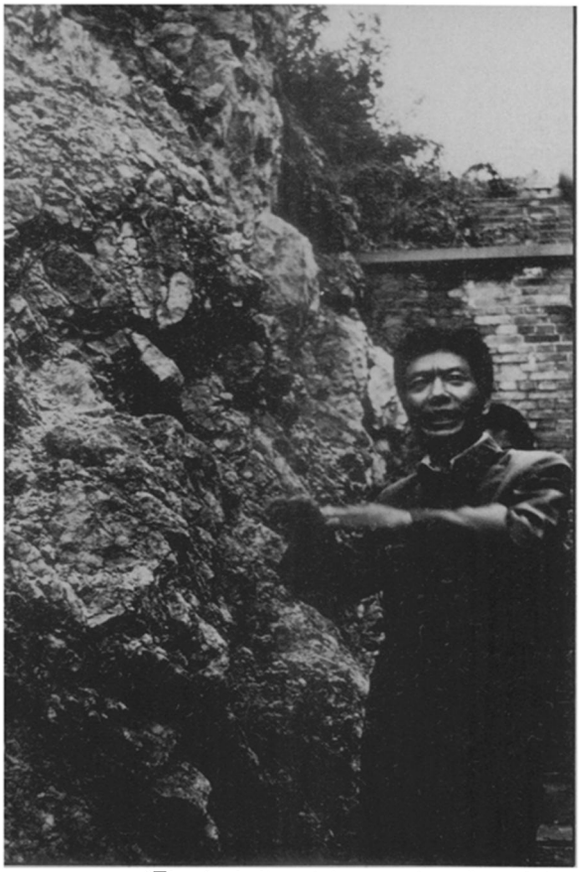
SEISMOLOGY

Fang said that seismology is one area in which China can make immediate contributions, and if the claim is true that they saved more than 100,000 lives by accurately predicting the 1975 quake that destroyed most of the city of Haicheng (SN: 7/26/75, p. 55), they probably can. But lessons to be learned from Chinese seismology most likely will have more to do with organizing a quake-prediction apparatus than with seismological or geological expertise.

The Chinese interest in earthquake prediction is only natural. China has had a long history of devastating quakes like the one that hit Haicheng and the one that killed several hundred thousand people and flattened Tangshan in 1976 (SN: 9/1/79, p. 50). The seismically active Ba Bao Shan fault runs through parts of Beijing and poses a threat to the 20 million persons who live in the area. While there, we visited the Dahui Chang Observatory for Ground Deformation, which sits astride the fault southwest of Beijing.

The function of this observatory is to monitor vertical and horizontal movements of the fault and attempt to relate those movements to earthquakes. The instrumentation above and below ground is simple and effective — levels, tiltmeters and a piezoelectric strain gauge to measure pressure across the fault.

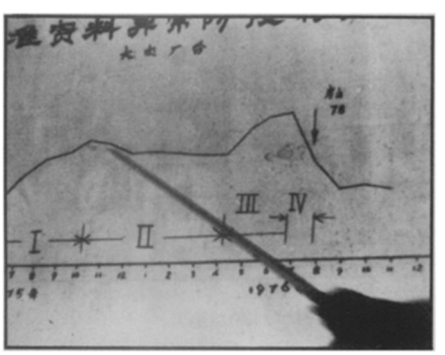
No recent anomalies have been recorded, but in May of 1975 the level instrument began to measure a significant



"The fault lies right over here," explains seismologist Chen Bin.

vertical movement of the eastern wall of the fault relative to the western wall. At the same time the strain gauge indicated that the eastern wall was being thrust against the western wall. The 24-meter quartz bar across the fault was compressed 0.3 mm during a 14-month period. Between May and October of 1975 the upward movement of the eastern wall proceeded at a more intense rate. A calm period followed, and then the wall began to move up rapidly in June of 1976. One month later fault movement reversed, and ten days after that the city of Tangshan, 180 km east of the observatory, was destroyed by an unpredicted earthquake. Several days later the fault was back to normal.

Seismologists and geologists at the observatory said they knew a quake was coming but not where or when. Other observatories further south along the fault had recorded similar data, and these are among the types of anomalies used to successfully predict the Haicheng quake. It has been rumored that the Gang of Four prevented the use of these and other data in the possible prediction of the quake, but the researchers said their ability to accurately predict earthquakes is still in its initial stages. The anomaly they recorded would not have been sufficient to make a reliable prediction. Other factors, such as water table levels, radon levels in well water, electric currents in the ground, knowledge of the geologic structure and even animal behavior patterns are all studied before a prediction is made.



A decrease in activity preceded quake.

China's quake-prediction program begins with geological studies and historical records. If a certain area is known to be active it is assigned a "long-term" prediction status (no quakes expected within the next ten years). Seismological monitoring stations are then set up, and if any anomalies are found the surrounding area is demarcated for intensive observation and put on "medium-term" status (a quake can be expected within two to three years). Tangshan had been assigned this status. If more anomalies are found the area is given "short-term" status (several months), and mobile seismic stations are sent in to look for imminent precursors, such as foreshocks, water-level, radon or geomagnetic field changes. If such changes are found, the area is put into the "imminent" status (quake expected in less than two weeks).

During the final stages of risk assessment, high school students, commune members and other "barefoot" seismologists are mobilized to do various types of monitoring — water levels, earthquake lightning, earth noise, animal behavior (prior to the Haicheng quake hundreds of snakes were reported to have come out of the ground, something they don't usually do during winter hibernation). All data are then forwarded to Beijing for evaluation by the State Seismological Bureau, which makes the final decision to give a public warning. They have only been right once so far, but it was a valuable, life-saving prediction.

PSYCHOLOGY

In 1971 Harvard University psychologist B.F. Skinner heaped praise on the Chinese revolution for the accomplishments it had made. At the time this was not a very politic thing to do. "Capitalist pigs and imperialist running dogs" is how we had only recently been described by the Chinese. But Skinner was speaking of psychology, not ideology. His praise was for the way the Chinese leaders had effectively applied many of the techniques of behavior modification in shaping and molding the largest society in the world. And many of those techniques can be seen in use throughout China today.

Programing begins at a very early age. At one point we visited a day-care center and were greeted by three-year-old children chanting a Chinese welcome and singing "A,B,C..." The next song, however, was about "our great leader Chairman Hua, who is leading us on a new long march," and "thanks to him the Gang of Four is smashed." Even the children learn to spout the Party line.

Positive reinforcement is used in all areas of society. An incentive system run by the state gives rewards (scholarships, cash) for outstanding scientific and technological achievements. Factory workers and commune members are similarly rewarded through national and local programs. Progress charts, another favorite tool of behavior modification, are posted in conspicuous places as constant reminders of how well or how poorly various programs are proceeding.

Disincentives are also used, especially in the population control program. Couples who have a second child lose various free medical and educational benefits for their children. Couples who have a third child may even be forced to take a ten percent cut in pay. Public censure is also used. A song that drew a lot of laughs at a concert in Shanghai ridiculed a couple who continued trying to have a son after producing two daughters. They failed and had another daughter. "This is the height of folly," went the song, "keep planned parenthood in your heart." Numerous other songs at the concert also contained obvious political messages.

Group therapy, in the form of self-criticism sessions, goes on in universities, factories and communes. And individual self-criticism may consist of having a factory worker or university student who has stepped off the party line write a self-criticizing essay that becomes a permanent part of his or her record. These and various other techniques are being used to build a society that is controlled in much more obvious ways than is ours.

Academically, however, "psychology is not flourishing," says the president of Hangzhou University. Meng Chaolan, a psychologist at Beijing University, explains that only now is psychology getting back on its feet after having been ignored for the most part since 1949. A department of psychology was established at the university last year and various courses are now being taught.

The university has access to psychology texts and magazines from abroad and now receives most of the American Psychological Association journals within several months of publication. Very little research is going on, says Meng, but the eventual goal is to do research that can be applied to the needs of society. She mentions specifically developmental, educational, clinical and industrial psychology. But, she says, "we will need a long time to apply this research."

ENERGY

The energy crisis does not exist in China, says Fang. Last year, he explains, "we produced a total of over 600 million tons of coal, leaving a tiny gap as compared with the United States. We produced, last year, 100 million tons of petroleum." And there should be more in the near future. A joint U.S.-China venture recently struck oil off the coast of China.

But with the rapid industrialization that China hopes to achieve, energy will become more and more a vital issue, and Fang admits that China "will have to take into account the energy question and keep it in the forefront of considerations." He points out, however, that "China enjoys a natural and unique advantage in that the peak of the world [the Himalaya Mountains] is situated in our country." This gives rise to an abundance of water reserves, and it is estimated that hydropower generation could exceed 500 million kilovolts. Only two percent of that potential is now being put to use, but during Vice President Walter Mondale's recent visit to China, preliminary talks began on a joint U.S.-China hydrogen generation project near the Yangtze River gorges.

China had entered into negotiations with France to jointly build two nuclear power stations, but the abundance of hydropower reserves was instrumental in China's recent decision to hold off on such an expensive proposition. "We believe that nuclear power has bright prospects for the future," says Fang, but "why should we spend an enormous amount of money to build nuclear power stations now that we have so much hydropower to be utilized?"

Public concern over the possible dangers associated with nuclear power generation may have been another factor influencing China's decision to put nuclear on the back burner — at least temporarily. Fang says the question of Three Mile Island is something the Chinese will study. Wu Minyu of the State Commission for Science and Technology is optimistic about eventual solutions to any technical problems associated with nuclear energy, but he says, "we want to avoid mistakes made by other countries."

The United States has been wasteful, says Wu. Natural gas, tar sands and oil shale are not utilized fully. Solar power, sea power and biomass conversion, he suggests, should be developed. China, for instance, is lighting the lamps and cooking the food of millions of farmers with methane generated from waste material. A family that has two pigs produces enough waste (human and animal) to generate methane to do all their cooking and to light one lamp. The waste, plus a few leaves, produces methane during an anaerobic process in an inexpensive biogas unit. Seven million such units are in use on communes in China.

With five times as many people to feed from only the same amount of arable land as the United States, China must make the most of every bit of land.

ENVIRONMENT

The wok, the all-purpose Chinese cooking utensil, is specially shaped to provide intense heat for rapid cooking. This is important where fire wood is in short supply, and that is a continuing problem in China, a country denuded of trees during thousands of years of habitation. China has an acute shortage of wood for heating, cooking, building and paper production, and the lack of trees has resulted in serious erosion problems. The Yellow River runs yellow because there are so few trees up river to hold the soil.

China is tackling this problem with an intensive reforestation program, the signs of which are visible in cities and countryside. Beijing, a windy, dusty city that needs all the protection trees can provide, will be a city of broad, tree-shaded streets in ten years if all the trees that have been planted survive. In southeastern China every usable inch of land is cultivated, and where crop production leaves off reforestation begins. The sides of mountains and slopes of hills are neatly lined with rows of recently planted trees.

The beautifully cultivated countryside

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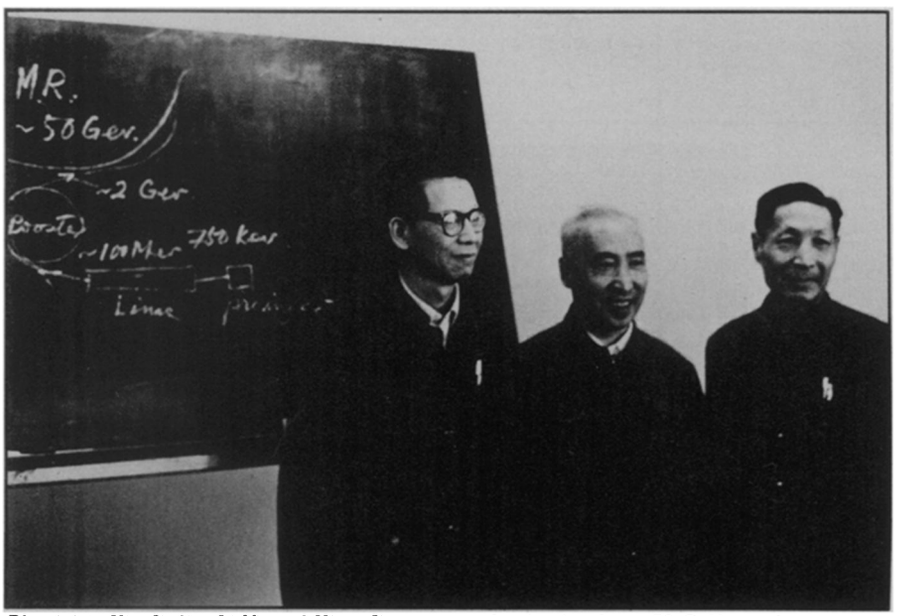
presents a stark contrast with the crowded, noisy, polluted cities. Factories and coal-burning trains belch forth black clouds. Horns honk and bicycle bells ring from early morning till late at night. Indoor plumbing is the exception, not the rule.

The Chinese realize they are between a rock and a hard place with regard to their serious pollution problem. They want to industrialize and raise the standard of living as rapidly as possible, but they know this goes hand in hand with increased pollution unless drastic, expensive measures are taken—and China's economic capability is limited. Nevertheless, a first major step in the fight against continued environmental degradation has been taken.

Last month, a wide-ranging environmental protection law was passed at the 5th People's Representatives Meeting. It calls for a "sensible use of the natural environment" and covers everything from land, sea, air and noise pollution to protection for wild plants and animals, sightseeing spots and people's living areas. It calls for environmental impact statements, emissions standards, scientific research, educational programs and heavy fines for violations.

If the Chinese have learned from the mistakes of others it will be evident in the strictness with which they enforce this new law.

HIGH ENERGY PHYSICS



Physicists Xie Jialin, Li Yi and Xiao Jian are enthusiastic about 50 GeV accelerator.

The contrast between old and new is highly visible at the Institute of High Energy Physics in Beijing. Inside, physicists are moving ahead rapidly with the design and manufacture of prototype hardware for a 50 GeV accelerator. Outside, women and children are among those digging ditches in the labor-intensive construction of the institute's new building.

Why would a country that has so far to go in achieving its goal of modern industrialization be willing to invest $200 million in a basic research project that has little value in terms of immediate applications and is already almost 20 years out of date by Western standards? The Chinese offer two answers. They believe in the value of basic research and in the principle of self-reliance. "From basic research to applied research and productivity is a comprehensive process," says Yong Longkuei, director of planning for the State Commission on Science and Technology. We have a commitment to this type of "big science," explains Xie Jialin, designer of the Chinese accelerator. The comprehensive research involved in the accelerator project, he says, "will improve the level of our science and technology, improve the training of our personnel and improve the industrial level of our country." The construction of the 200-meter-radius accelerator and the manufacture of its equipment are expected to make a practical contribution to the economy.

The Chinese have already sent physicists to the United States and Western Europe to study accelerator design and construction, and it is possible that they could have imported the technology for a much more impressive project, but their plan is to become self-reliant. They intend to build the accelerator themselves and eventually use it as a training facility for a new generation of physicists.

The plan for the accelerator, which will be called the Beijing Proton Synchrotron, was set forth at the 1978 science conference. It was originally scheduled for completion by 1982, but construction is not scheduled to begin until next year and the current plan calls for completion by 1985. "This is our first such accelerator. We have no experience," explains Xiao Jian, director of experimental physics at the institute. Future plans, however, call for the use of the main ring of this accelerator as a booster for one with even greater capacity —perhaps by 1990.

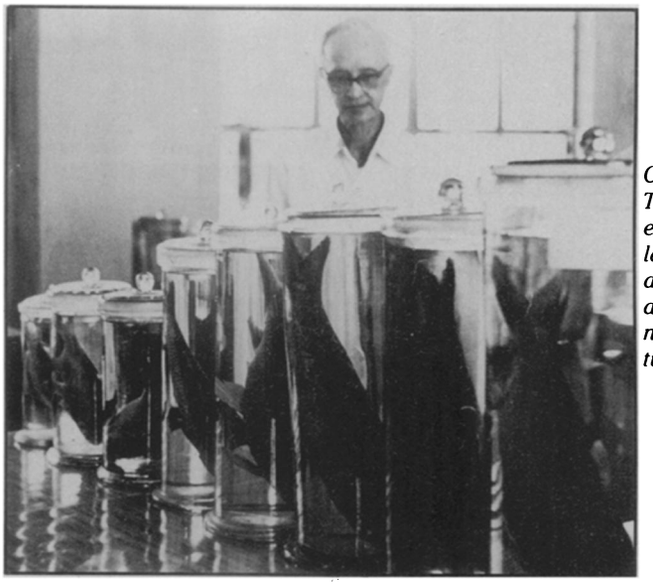
With regard to the future of high energy physics in China, Li Yi, director of the institute, says "we are trying to catch up with the rest of the world by the turn of the century, but that will be a very hard thing to do.... The Gang of Four ruined our foundations." Li was prevented from doing research during the Cultural Revolution, but he says he is pleased with the support currently being given by the government and with the high status the Institute of High Energy Physics enjoys within the Chinese Academy of Science. He speaks with pride of recent accomplishments (the planned accelerator will be one of the most energetic in Asia) and the fact that work is now going full speed ahead. "After the smashing of the Gang of Four," he says, "everyone just wants to get back to work."

AQUACULTURE

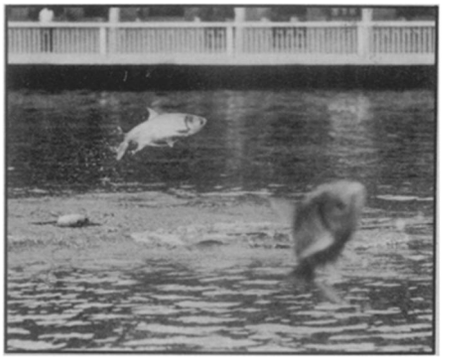
More than half the fish eaten in China, according to one estimate, are produced in an intensive aquaculture program. Lakes, ponds, reservoirs, even irrigation canals are stocked with carp that eventually end up on someone's table. And this adds up to a lot of fish in a country that relies heavily on fish as a food source for its vast population.

At the Pearl River Fisheries Research Institute outside of Guangzhou, aquaculture is being studied and a United Nations-sponsored training program for Third World fish farmers is entering its sixth year. The research effort concentrates on selecting and cultivating strains of fish best suited to aquaculture, developing more efficient methods of farming fish and preventing fish diseases.

The research has paid off in several ways. One problem with carp, for instance, is that they usually refuse to spawn in still water. For a thousand years Chinese farmers had to collect fry (young fish) from streams and rivers and transport them to ponds. In 1958 Chung Lin of the Pearl River Institute solved this problem when he succeeded in using injections of pituitary hormones to induce spawning. This saved farmers the trouble and expense of transporting young fish, many of which did not survive, but producing the hormone, which was processed from the urine of pregnant women, also proved to be time-consuming, expensive, and difficult. The Institute of Biochemistry in Shanghai solved this problem by synthesizing an analog of LRH that proved to be highly effective in inducing spawning. The syn-



Chung Lin: The fish disease control laboratory is an important aspect of China's aquaculture effort.



thetic LRH is now inexpensively mass produced and used throughout China. (The Biochemistry Institute in Shanghai has had a history of such successes and was one of the few research facilities not shut down during the Cultural Revolution. In 1965, researchers there scored a first by synthesizing insulin, the first protein ever synthesized.)

Regardless of the success of Chinese aquaculture, especially its high production rates, aquaculturists who have seen the Chinese system say it is backward compared with the technologically advanced systems being used in the United States, Japan and the U.S.S.R. But the true value of the system lies in its applicability to developing nations.

One aspect of Chinese aquaculture that is especially appealing to developing nations is its emphasis on energy and cash conservation. In China, aquaculture is closely integrated with farming and animal husbandry. Agricultural and animal wastes make up 95 percent of the fish food. Anything the fish don't eat just helps fertilize the pond. U.S. and Japanese methods use relatively expensive fish food. Chinese carp have been exported to several countries and have been integrated successfully with indigenous fish. Trainees at the Pearl River Institute have come from Burma, India, Indonesia, the Philippines, Thailand, Pakistan, Nepal, Bangladesh and Sri Lanka.

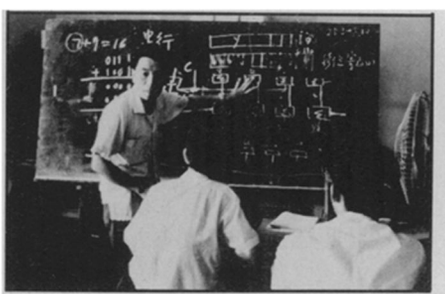
THE CHILDREN'S PALACE

China lost a generation of science and scientists to the anti-intellectualism of the Cultural Revolution, but the future lies in the hands of China's children. And those children are growing up in the midst of a mass movement to popularize science and technology. An important factor in this movement is an institution known as The Children's Palace.

Children's Palaces are educational and cultural facilities at which exceptional children are given extra training in areas in which they excel. Even in China's supposedly classless society, excellence is sought out and rewarded in an effort to fill in the gap left by the Cultural Revolution. Students at the Children's Palaces get the best teachers and equipment free of charge and are encouraged to make the most of their abilities.

The first Children's Palace was established in Guangzhou in 1953, and now there are Children's Palaces in most Chinese cities. Shanghai, for instance, has eleven. Children between 6 and 16 years of age who have passed a strict entrance exam come for specialized tutoring after school and on Sundays. Summer camps that specialize in science and technology are also part of the program. At the main Shanghai Children's Palace (which is indeed a palace, having been the mansion of a British merchant in the 1920s) we saw classes being conducted in biochemistry, mathematics, electronics, astronomy, meteorology as well as various cultural, sports and artistic activities. The children we saw were obviously the cream of the crop. They were making televisions and programing computers and in the electronics laboratory some were studying an issue of WIRELESS WORLD that had plans for a radio-telescope. "The students are going to build their own," said their teacher.

But the Children's Palace is supposed to build something even more important — a scientifically and technologically aware society with which to face the future. □



Electronics, biochemistry and meteorology are among the science courses available.