prising that anomalous sea-surface temperatures were found over the North Atlantic, with colder-than-normal water in and to the west of the Icelandic quasi-stationary depression and warmer-than-normal water to the east. The mean anomalies in sea-surface temperature for the nine seasons from September 1958 to November 1960, as indicated by weather ship observations, are given in Fig. 9. Actually, this pattern of water temperatures became established by late spring and summer of 1958, preceding inception of the blocking.

Here again is the suggestion of an external forcing agent producing anomalous cyclogenesis (and cyclonic vorticity), forcing storms more to the north than to the east, thus providing more frequent and stronger southerly components of wind than normally occur at upper levels east of the Icelandic Low. These winds, in turn, helped create a ridge over northern Europe, in contrast to the flat westerly flow normally found there (see *13*).

Finally, attempts are being made in the Extended Forecast Division of the U.S. Weather Bureau (*14*) to develop quantitative physical methods for testing the validity of these ideas.

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Science in Mainland China: A Tourist's Impressions

Visits to universities and research institutes show significant efforts to bring science to the people.

C. H. G. Oldham

In 1958 J. T. Wilson, professor of geophysics at the University of Toronto, spent a month in China as a guest of the Academia Sinica in Peking. He went in his capacity as president of the International Union of Geodesy and Geophysics to see scientific work in geology and geophysics, and he has reported on his observations (*1*). I had studied under Professor Wilson, and one by-product of his visit was an intensification of my interest in scientific developments in Asia and in studying the Chinese language. Despite several requests to Chinese scientists and the Academia Sinica, it has never been possible for me to visit China in my capacity as a geophysicist. So, when, in the spring of 1964, a Canadian travel agency was invited by the Chinese Government to send a group tour, I applied to join, to visit China as a tourist. Ultimately all other members of the tour withdrew, and I was able to visit China on my own.

Initially the tour was for 2 weeks in mid-October 1964, but once in China I had no difficulty in extending my stay to a month. I spent a week in Peking, 5 days in Nanking, 3 days in Soochow, a week in Shanghai, 3 days in Hangchow, and 3 days in Canton. I flew from Canton to Peking but made the return journey by train.

In Peking I saw all the classic tourist attractions, but my requests to visit the Academia Sinica, the university, and the Museum of Peking Man were refused. Nanking was quite different. There my requests to see the university, research institutes, a commune, and a scientific instrument factory were approved, and only my request to see the Purple Mountain Observatory was rejected—on the grounds that the road was under repair and impassable. In the other cities I visited I was able to visit schools, universities, and communes, although nowhere else was I able to visit a research institute.

From the point of view of my scientific specialty of geophysics the trip was disappointing. In fact I saw no scientific research work on which I am qualified to pass a professional judgment. But from the point of view of the study of scientific development in Asia the visit was quite rewarding. My visit was in many ways superficial, and although previous study, in Hong Kong, of Chinese scientific developments added some depth to my observations, it would be quite wrong to conclude that the conditions I saw are typical of China as a whole. But first-hand reports of Chinese science are fragmentary at best, and my impressions may add a few more pieces to the jigsaw puzzle of Western knowledge of Chinese science.

My visits to institutions followed a set pattern. I would arrive at the appointed time accompanied by an interpreter supplied by Luxing She (China International Travel Service). Invariably there would be a "reception committee" waiting on the steps of the institution—usually consisting of a professional man, an administrator, and a secretary. We would go into a committee room and, after an official welcome, I would be given a "brief introduction." This introduction was frequently political and gave a Before and After Liberation comparison (*2*). I found that interruptions were not wel-

The author, who lives at 27 Lugard Road, The Peak, Hong Kong, is a geophysicist, formerly affiliated with the Standard Oil Company of California.

comed during this speech, but that afterward I was free to ask questions.

Although my Chinese was adequate for ordinary conversation it was likely to let me down in formal interviews where it was important to get precise meanings. So, after assessing the competence of the interpreter, I usually relied on him and concentrated on the substance of the interview. The professional people answered professional questions, but the administrative personnel answered all questions with a political bias. My questions were always direct, and the answers were usually equally frank. During the question time the secretary from the institution made notes both of my questions and of the answers given. I once asked why notes were made and was told that sometimes useful ideas arose from question-and-answer sessions such as this. I also took notes on most occasions. After the question period we toured the institute and then returned to the committee room for further discussions. Finally I would be asked to state my opinions and give criticisms of what I had seen.

I visited three comprehensive universities, one agricultural university, three research institutes, seven communes, two instrument factories, and six middle schools (high schools).

Universities

The universities which I visited were Nanking University; Fu Tan University, Shanghai; Sun Yat Sen University, Canton; and Hangchow Agricultural University. The information which I was given at the introductory talks and in answer to questions is compiled in Table 1 and in the following paragraphs.

Communist Party policy for higher education. Wang Der-jy, director of Teaching Affairs at Nanking University, outlined aspects of the higher education policy of the Communist Party. He said (*3*): "This is a socialist university run on the basis of the educational policy of the Communist Party. The University aims to train all-round developed students, with a high social consciousness, and a high degree of culture and knowledge. In brief, we train the students morally, intellectually, and physically.

"We carry on the policy of education in ideology and politics. All students must learn the works of Chairman Mao, Marx and Lenin. In addition the students must be concerned with important issues both national and international. They must take part in productive labor so that they are enabled to have the viewpoint of labor. Every student takes part in this labor for one month a year. It can be in a factory or in the countryside. It is considered an important part of his education.

"Teaching is done according to plan and the characteristic feature of teaching is as follows: First, theory must be combined with practice. This means the students must make experiments in the laboratory and also field experiments and demonstrations in their specialties. Secondly, we follow the policy of giving as much basic theory as the student can master—that is, we stress quality rather than quantity. Thirdly, we teach the students to be self-reliant and show them how to educate themselves. There are only three or four periods a day, so that the students have time to study on their own.

"Students are also trained for research work. In the lower classes they are divided into groups for simple research. For example, in biology they make collections of plants and specimens. They also participate in seminars. In the higher classes they begin to do independent research. Every student must write a thesis before graduation. The principal purpose is to train students to be in a position to master the latest science.

"Physical training is given in the

Table 1. Statistics relating to universities visited in eastern China (*6*).

University	Date of founding	Students (No.)	Teaching staff (No.)	Duration of courses (yr)	Departments*	Time spent in study of politics by all students	Research students (No.)	Floor space (m^2)	Books in library (No.)	Days spent in labor per year
Nanking	1902	(1949) 600; (1964) 6000	(Before 1949) 200; (1964) 1000	5	Chinese language, foreign language, history, politics, physics (1100 +20), chemistry (700) geology (600), mathematics, geography, biology, meteorology, astronomy (200 +5)	3 periods per week, plus reading and discussions	100	?	?	30
Fu Tan, Shanghai†	1905	(1949) 2000; (1964) 5000	(Before 1949) 200; (1964) 1000	5	Chinese language, foreign language, history, journalism, philosophy, economics, politics, mathematics, physics, chemistry, biology	Natural scientists, 10%; social scientists, 20%	180	160,000	1.1 million	35
Sun Yat Sen, Canton	1924	(1952) 994; (1957) 2000; (1964) 4300	(1952) 202; (1958) 380; (1964) 750	5	Chinese language, foreign language, history, philosophy, geography, mathematics, biology, chemistry, physics (900)	Natural scientists, 12%; social scientists, 18%	?	120,000	1.65 million	½ per week plus some time at harvest
Hangchow Agricultural	1910 (School) 1952 (Univ.)	(1952) 200; (1964) 2500	(1964) 420	4 and 5	Agriculture, plant protection, soil and fertilizer, horticulture, tea planting, sericulture, agricultural mechanization, livestock and veterinary	10%	Few ‡	80,000	220,000	?

* Initial numbers in parenthesis are number of undergraduates in the department; numbers following plus sign are numbers of postgraduate students.
† At Fu Tan University 70 percent of the students are in the science departments. ‡ For example, the soil and fertilizer department has three.

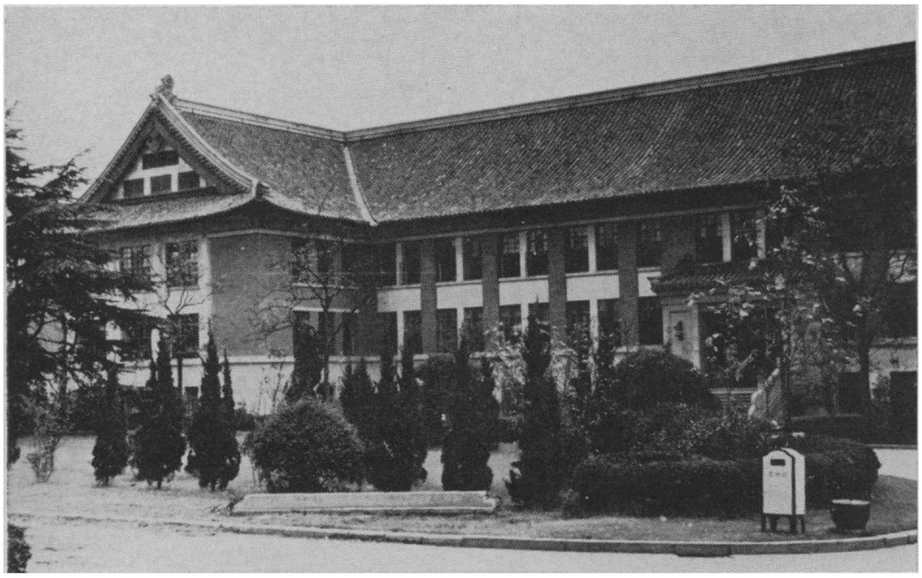

Fig. 1. Geology department building, Nanking University.

lower classes, but there is no formal instruction in the higher classes, although everyone still does some physical exercises each day. Also, many students take part in recreational sport."

Entrance requirements. To be admitted to a university, students must first of all be graduates from a middle school. They must then sit for a State examination. Students are admitted to a particular university on the basis of the needs of the State, results of the examination, the inclination of the students, their health, and politics. "We look for all-round development," said Wang Der-jy. I found it hard to assess the part played by politics in the selection of students, but the percentage of children from peasant families at Sun Yat Sen University in Canton increased from 17 percent in 1953 to 64 percent in 1963, and in Nanking I was told that most students are from peasant families. Other things being equal, a student from a peasant family stands the best chance of selection. The ratio of the number of students admitted to the number who applied for admission varied from about 1 in 4 at Nanking University to the 1 in 20 from Anhwei Province who applied to go to Fu Tan University in Shanghai.

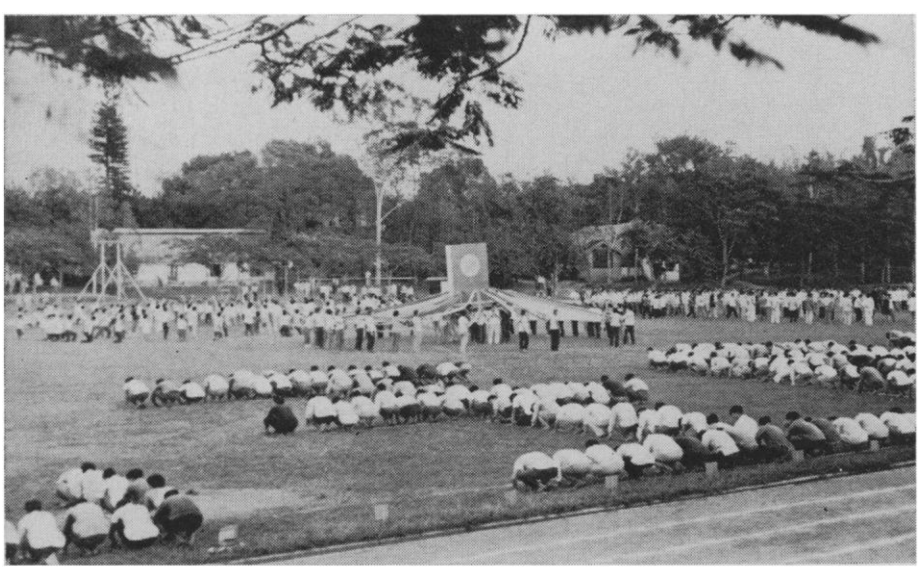

Fig. 2. Students at Sun Yat Sen University, Canton, practicing for a political display marking the 40th anniversary of the founding of the university. The students crouching in the foreground are forming characters, part of a slogan which reads "Long live Chairman Mao." Those in the center are parading, Maypole style, around a huge model of one of the volumes of *The Selected Works of Mao Tse-tung.*

Course work. Once admitted, the students study for 5 years. The curriculum for the first 3 years is usually general, students from one department having some lectures in other subjects. For example, for the first 3 years students in physics also take mathematics and chemistry. For the final 2 years the students specialize on one branch of their principal subject, and in their final year they must write a thesis based on the work done in their specialty.

Examinations are given annually, but if a student fails he can usually sit for the examination again. Once admitted, very few students are obliged to leave the university before completing their course. These examinations are internal university examinations, but the curriculum is set by the State. Occasionally in some subjects the university sets its own curriculum, but this must also be approved by the State. One foreign language is compulsory for all students, and a second one is optional. English and Russian are the most common, although French and German are also offered at most universities. It seemed that English was the most popular.

Job assignment. After graduating, some of the best students are selected to remain for 3 more years to do postgraduate work, but the rest are assigned to jobs according to the needs of the State. The students can express a preference, but when I asked if the students could change jobs once assigned, Mr. Wang at Nanking replied, "Most students offer themselves unconditionally to the State. I have never heard of any wanting to change jobs; I'm not sure whether it would be possible for them to do so if they did want to." However, in Canton I got a different story. Here I asked what contradictions the university had faced. (This was always a useful question, since Mao Tsetung has written that there will always be contradictions and most people felt obliged to tell their problems when the question was couched in his terms.) I was told that one of their biggest contradictions was the fact that some students wanted to choose their own jobs; they did not want to be assigned jobs by the State.

Research. In the comprehensive universities most staff members are expected to do some research, and each department had a handful of research students, but, as compared with most North American and British universities, the amount of research was very small. For example, the physics department at Nanking University had 1100 students but only 20 were postgraduate students.

Most of the research effort over the past 5 years in all the university departments I visited had been concentrated in designing and building teaching apparatus for 4th- and 5th-year laboratories. Only once, in the geology department at Nanking University (Fig. 1), was there any reluctance to discuss research work. When I pressed for details I was told that it was research having to do with socialist reconstruction. I asked whether this meant a study of economic minerals, and was told, "and rocks!"

Politics and the student. The amount of time which the student must spend in politics varies from university to university but averages 10 percent of total study time for a natural scientist and 20 percent of total study time for a social scientist. Once when I suggested that this was rather excessive, I was told, "We consider political education of our youth to be most important. The Western countries realize that they can do nothing with our present leaders, but they say that within two or three generations capitalism will return to China. We are determined to make sure it will not."

All students and junior staff members must devote a month to productive labor. This is usually at harvest time, although some students in Canton were spending half a day a week at such work during the 36-week university year, and another 2 weeks at harvest time. Those I saw doing this work all seemed to be enjoying themselves, and I noticed one girl at Hangchow University lightheartedly sprinkle a couple of boys with her watering can as she passed them. However, it was freely admitted that some students were reluctant to do manual work. The Oriental tradition of the scholar who refuses to dirty his hands dies hard even in Communist China.

Student life. Students pay no tuition fees and many (75 percent at Sun Yat Sen) receive maintenance grants from the State. Most textbooks are provided free, and medical care is also free. All the students at Nanking University lived in halls of residence. A wide range of clubs exist for extracurricular activities. These are organized by the students themselves, through their students' union.

About one-quarter of the students are women. When I asked about dating and student marriages I was told there was very little; "the students are educated not to talk about love"—and there appeared to be little action either. Western-style dances are never held at Nanking; I did not inquire about this at the other universities.

I saw most evidence of extracurricular activities at Sun Yat Sen University. After the formal visit I suggested to my interpreter that we stroll through the very delightful campus. It was late afternoon and we passed a group practicing folk dancing, another group doing militia training (with fixed bayonets), and a large group of students practicing for a political display they were to perform the following week at the University's 40th anniversary celebration (Fig. 2). The biggest surprise, however, was to see several men practicing dirt-track racing with motorcycles.

Staff conditions. There are four grades of teaching staff: professor, assistant professor, lecturer, and assistant lecturer. University staff members receive a comparatively good salary for China—a full professor, for example, earns more than 300 yuan a month ($125 in U.S. money). This is six times the average salary of a factory worker or a commune director and almost three times the top salary paid in the Shanghai textile factory I visited. In addition, university staff members are provided with a house at a rental of only 3 percent of their salary, and all receive free medical care (dependents must pay 50 percent of medical costs). The professors are also eligible for free vacations at holiday resorts.

Fig. 3. Chemistry department building, Fu Tan University, Shanghai.

Some of the senior staff carry out their research at nearby research institutes of the Chinese Academy of Sciences. Fu Tan University has its own "spare time college," where staff members can take extra courses in their spare time to increase their knowledge. At Sun Yat Sen University the senior staff spend more time on research, the junior staff doing more lecturing.

I found all the academic staff members I met extremely affable, and all seemed delighted to show off their laboratories. I visited Nanking University on the afternoon following the announcement of the explosion of the Chinese atomic bomb; all the scientists there seemed in a particularly good humor and were obviously excited by the news.

Campus conditions. Sun Yat Sen University, in Canton, has a delightful campus. Spacious grounds, hills, ponds, trees, gardens, and lawns separate the teaching buildings and provide a pleasant academic atmosphere. Nanking University is also well laid out. New buildings have been constructed in the same architectural style as the old, with curved Chinese roofs. The buildings of Fu Tan University in Shanghai are strictly functional (Fig. 3).

Academic standards. This is one of the most important aspects of any university and, at the same time, the most difficult to judge on a superficial visit. I found two clues to standards: the experimental work which I saw in the

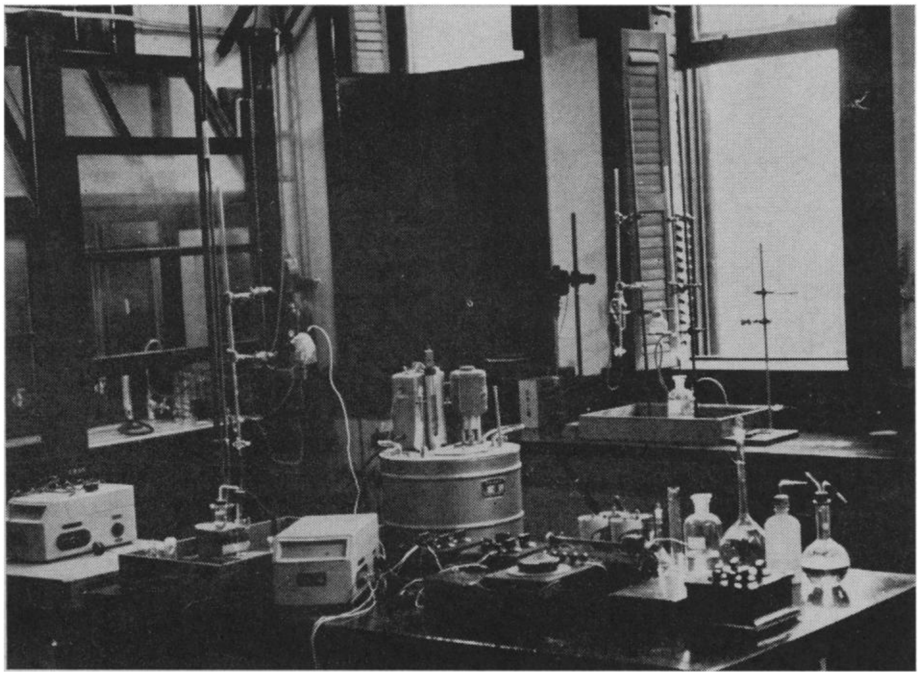

Fig. 4. A corner of the 5th-year chemistry laboratory, Nanking University.

laboratories and the academic standards reached by students from China who later studied at the University of Hong Kong.

The 1st- and 2nd-year physics laboratories of all the universities I visited were equipped for basic physical experiments similar to those performed in 1st- and 2nd-year laboratories at Toronto University when I was a demonstrator there 12 years ago. The 4th- and 5th-year laboratories were equipped for quite advanced experiments. The emphasis in physics was mainly on applied physics. Since none of the laboratories were for work in my own specialty, I will reproduce my notes, so that scientists can make their own judgment.

Nanking University

Geology Department. Saw petrology, optical mineralogy, paleontology, sedimentary petrology, and economic minerals laboratories. Sedimentary petrology had specimens with English-language labels, obvious relics of pre-1949 days. I noted one specimen labeled "Ordovician Sandstone, North Dakota." Department has 100 petrological microscopes, many made in China. Saw spectroscope for chemical composition of minerals, and German x-ray apparatus for crystal structure determination.

Chemistry Department. I was shown the 4th-year laboratory for experiments in electrolysis and spectroscopy. Students learn how to repair instruments. Chemistry students seemed proficient at electronics. Fifth-year laboratory [Fig. 4] contained a polarograph, sensitivity 10^{-10} gm. (chemists at the University of Hong Kong tell me this is high, but likely to be genuine since Nanking University has a noted Chinese expert on polarography on the staff). Also saw quartz prism spectrometer made in Nanking for use of students. In the next room there was a glass prism spectrometer for staff use and research. Was told both instruments could determine all elements in the periodic table.

Physics Department. Saw only 1st-, 2nd-, and 3rd-year laboratories as time was running short. Therefore given option of seeing Astronomy Department or the senior-year physics laboratories. Chose the former.

Astronomy Department. Has 28 cm diameter refracting telescope built before 1949, but all spare parts made at the University. It is mainly used for studying the brightness and spectrum of fixed stars. Also saw smaller 16 cm diameter telescope used for sunspot studies. Department has close scientific ties with the nearby Purple Mountain Observatory.

Fu Tan University, Shanghai

Physics Department. This was the best equipped department that I saw in any university in China. It has 200 oscilloscopes. I was shown the microwave laboratory for 4th-year students. All apparatus had been designed and built in the University. It had taken 1½ years and was completed in 1961. The 5th-year semiconductor laboratory had 21 experiments which are performed individually by each of the 70 students specializing in solid state physics. The experiments included: parameters of transistor amplifiers; effect of temperature on transistors; the electrical capacity of transistors; the maximum oscillatory frequency of transistors; and transistor noise characteristics. In another room there were experiments to measure the lifetimes of semiconductors [Fig. 5]. Four methods were used: photomagnetic effect; lens diffusion; double pulse; and photoconductivity decay. Also saw another laboratory where dislocation studies of germanium were carried out with a Zeiss metallurgical microscope. The final laboratory I was shown was equipped for plasma spectroscopy. It contained a grating photometer and was a part of the 5th-year course, to study the fundamental properties of plasma. This equipment had taken a year to build and was completed in 1960.

Chemistry Department. I saw only the kinetics laboratory. Most of the equipment had been designed and built at Fu Tan.

Biology Department. I was shown the biology museum, which was well stocked with specimens, nearly all of which were indigenous to China.

English Language Section of the Foreign Language Department. This section was well equipped with phonetics laboratory, soundproof rooms, classrooms with earphones arranged in eight rows so that each row could have different instruction. The walls of the classrooms were covered with English language slogans, including an enigmatic "Foreign languages are a weapon in the struggle for life." I was also shown the library and students' reading room. The only English language magazines available to the students that were not published in China were the American *Science and Society* and Marxist-Leninist journals from Australia and New Zealand. The teachers' library, however, had a good supply of philology journals from Western countries.

Hangchow Agricultural University

The science laboratories of this University were not advanced. The best equipped department that I saw was the soil science department.

Sun Yat Sen University, Canton

Physics Department. The elementary laboratories were well equipped, with students working in pairs on most experiments. In the 4th- and 5th-year laboratories I saw experiments in progress in molecular spectroscopy, with all the apparatus built by the University staff. I also saw a Zeiss microphotometer and 5th-year students studying emission spectra with a Raman spectrometer. There was Japanese equipment for the study of molecular absorption spectra, as well as several laboratories devoted to metal physics.

Another clue to standards can be gained from the academic achievements of those Chinese students from the Mainland who have later studied an experimental science at the University of Hong Kong.

The University of Hong Kong is modeled after British universities; English is the language of instruction. In science the university offers a 3-year course leading to a General Honours B.Sc. degree, plus a 1-year Special Honours B.Sc. degree. These degrees are recognized in Britain as of equivalent standard to those of a British university, and an external examiner, usually from Britain, assesses all examination papers and scripts for the degree. The university may admit students from other universities for the 1-year Special course if the head of the department concerned and the University Senate regard them as sufficiently qualified. In the chemistry department this Special course consists of advanced courses in all branches of chemistry (these resemble the 1st-year course for the Ph.D. at a U.S. university) plus experimental work which, since the 1961–62 session, has consisted of a research project in one branch of chemistry, on which the student writes a thesis.

Professor J. Miller, head of the chemistry department, admitted to the B.Sc. Special course in the period between 1960 and 1964 a number of graduates from other universities, including eight students who had previously studied at universities in Mainland China, and five more have been admitted to the current session. The achievements of these students are shown in Table 2 (*4*).

The sample is too small to permit one to draw firm conclusions from these results, and in assessing their significance the following factors must be borne in mind: (i) the date of graduation from the university in Mainland China and the time which had elapsed between that date and admittance to the University of Hong Kong; (ii) the type of work done in the intervening years; (iii) the problem of language difference, especially in a 1-year course; (iv) the fact that the students with the highest achievement had gone to a secondary school in Hong Kong before going to China for higher education. Nevertheless, the results do indicate that students trained in universities in Mainland China can fit satisfactorily into advanced-degree courses at a university with British standards.

Research Institutes

Only in Nanking was I able to visit research institutes. For permission to do so there I am indebted, I think, to the fact that few tourists visit Nanking, as compared with the many who visit Peking and Shanghai, and to the particularly obliging manager of the China International Travel Service. He said, "If we show universities and communes to most tourists they accuse us of ramming propaganda down their throats. They want to see museums and relics of the Old China; I'm glad to arrange for you to see something of the 'New China.' "

Two of the institutes were branches of the Chinese Agricultural Academy, and one was an institute of the Academia Sinica. All three were concerned with the improvement of agricultural production. It seemed that the overall objectives of each institute are determined according to a "united plan" worked out by the State. Their terms of reference are, however, quite broad. For example, the main task of the Kiangsu Branch of the Chinese Academy of Agricultural Science is to "solve the problems of agricultural production encountered in this Province." The Mechanization Research Institute had as its objective "to do re-

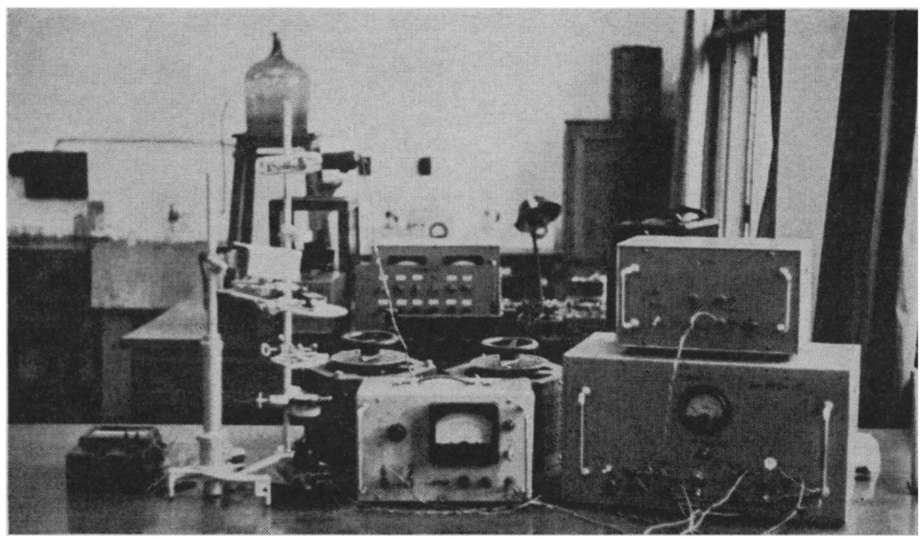

Fig. 5. Equipment in the 4th-year physics laboratory, Fu Tan University, Shanghai.

Table 2. Academic achievement and graduate careers, at the University of Hong Kong, of individual students who, after obtaining a degree in chemistry from a university in Mainland China, obtained the B.Sc. Special Honours degree at the University of Hong Kong.

University in Mainland China and date of graduation	Achievement at Hong Kong in work for B.Sc. Special Honors degree	Subsequent academic career at Hong Kong*	Remarks
		1960–61	
Sun Yat Sen (1953 or 1954)	3rd-class honors	Has since obtained M.Sc.	
		1962–63	
Sun Yat Sen (1949)	3rd-class honors	Now completing work for M.Sc.	
Shantung (Tsingtao) (1956)	2nd-class honors lower division	Now completing work for M.Sc.	
		1963–64	
Sun Yat Sen (1959)	2nd-class honors upper division	Now enrolled for M.Sc.	Secondary schooling in Hong Kong
Sun Yat Sen (1956)	3rd-class honors		
Sun Yat Sen (1959)	1st-class honors	Now enrolled for Ph.D.	
Fu Tan (1961)	2nd-class honors lower division	Now enrolled for M.Sc.	
Sun Yat Sen (1960)	1st-class honors	Now enrolled for Ph.D.	Secondary schooling in Hong Kong
		1964–65	
Fu Tan, Sun Yat Sen, Tientsin	Results (for 5 students) not available until June 1965		

*The M.Sc. degree of the University of Hong Kong is a 2-year research degree.

search to find the types of machinery most suitable for paddy rice production," and the Academia Sinica's Soil Science Research Institute was directed to carry out "basic studies related to improving the fertility of poor soils, especially saline, alkaline and red soils."

The scientists work out their research projects according to these terms of reference. In the case of the Kiangsu Branch of the Chinese Academy of Agricultural Science the working out of research priorities involves close liaison with branch institutes scattered throughout the province, and with the peasant scientists in the communes. The Soil Science laboratory, however, does more basic research, and the scientists seemed to have considerable say in their research program. In all instances the program has to be sent to Peking for approval.

Chinese Academy of Agricultural Science, Kiangsu Branch. This research institute has eight departments: food crops; fiber and oil crops; crop protection; soil science; horticulture; animal husbandry and veterinary; plant physiology; and agricultural physics. In addition there are two pedagogical research groups: agricultural economics and agricultural methodology.

There are 300 research workers plus 100 assistant researchers and four peasant scientists. Affiliated with this academy are seven agricultural scientific research institutes, one in each of seven districts within the province; two institutes for research on vegetables; one institute for research on poultry; and 17 experimental stations, one in each of 17 counties in the province. Altogether in these 28 institutes and stations there are more than 1000 research workers.

A particularly interesting feature of this institute and of its 27 affiliated institutions was the use of peasant scientists (Fig. 6). There are peasants who have no scientific training but have demonstrated an ability to innovate and have found "what works" in their home area. At the top level, as in Nanking, there were very few of these men. The work going on was clearly professional scientific work carried out by university graduates. But in the agricultural extension work considerable use was made of the peasant scientists. They act as a go-between, and their empirical knowledge is sometimes of use to the professional scientists. For example, in 1963 some 90,000 peasants visited the institute's experimental field in Soochow to see a demonstration of a new technique for growing rice which was attributed to a peasant scientist. However, his method had first been given a thorough scientific analysis at the Nanking institute before his ideas were promulgated.

Fig. 6. Yu Fuh-jou, a peasant scientist, demonstrates his seed germination experiment at the Agricultural Research Institute, Nanking. On the wall are displays showing common plant diseases.

As an illustration of the work of the Nanking institute, I was shown the pest-control laboratories in the crop-protection department. There, research on the life cycle of various insect pests is carried on, and a search is made for the most appropriate insecticides. There were 41 research scientists working in this department.

Nanking Agricultural Mechanization Research Institute. This institute was established in 1957. On the wall of the committee room is a quotation from Mao Tse-tung: "The basic road for our country's agriculture lies in mechanization." There are four laboratories: electric-cable-towed plough, plant protection, plant transplanting, and machine repair.

One hundred researchers work in this institute. They not only design new agricultural machinery, but also advise on the application of machinery and select machinery for specific problems. So far the institute has designed three types of machines which have been thoroughly tested and for which blueprints have been sent to the factory. I was shown all three.

The first is a machine for transplanting rice seedlings (Fig. 7); it can be adjusted to plant from 3 to 11 seedlings in each 20-centimeter square. It has a 2-horsepower motor, and, with it, five people can plant 1 hectare in a day (it takes 30 people to plant 1 hectare of rice in a day without a machine). I was told that the machine is exported.

The second machine is an insect sprayer. Basically it consists of a pump which draws water from an irrigation canal, mixes an appropriate amount of insecticide into the water, and then sprays the mixture over crops.

The third machine, and by far the most interesting, is the cable-drawn plough (Fig. 8). This is for operation in swampy ground, preferably ground covered with water to a depth of 10 to 15 centimeters. I watched it being demonstrated in a field outside the institute. At either end of the field was a punt-like boat on which was mounted a winch (powered by either an electric or a diesel engine). The plough was attached by cable to both winches and was simply pulled back and forth across the field. The boats were anchored and, by means of another winch, could be moved a furrow's width at right angles to the furrows after each traverse. The plough moved quickly, at 2 meters per second, and I was told that up to 6 mou of land could be ploughed per hour (15 mou equal 1 hectare).

The director of the institute, Ko Jie, was one of the very few scientists I met in China who was willing to speak to me in English. He said I was the first Englishman ever to have visited his institute. He personally demonstrated the cable plough, which he claimed is now in mass production.

Soil Science Research Institute. The Academia Sinica's Soil Science Laboratory in Nanking was the best-equipped scientific research laboratory that I saw in China, and compared favorably with anything I have seen elsewhere in Asia. I was given the usual political introduction, into which Mr. Chan, the director, crowded a great many slogans: "Under the three banners . . . ," "Rely on our own efforts . . . ," "Let 100 flowers bloom and 100 schools contend . . . ," and so on. In the midst of this political verbiage were some facts. I learned that there were more than 300 university graduates working in the institute, which has six divisions: soil geography, soil agrochemistry, soil physical chemistry, soil biochemistry, soil biology, and soil physics.

I was shown around many different laboratories. In each laboratory the project leader explained the work in progress. I noted that, although many of the scientists could read English, most were very reluctant to speak it. We visited the library, which, I was told, contains 60,000 volumes. There was a separate room for current journals; I estimated that there were about 300 journals on the racks, from all over the world. I noted British, American, Russian, French, and German journals; all appeared to be originals rather than photocopies. One American journal which I picked up at random was the July 1964 issue (it was then October). There were many Russian and English-language books in the library. Also I noted, as we went around the laboratories, that each scientist nearly always had on his desk a few of the latest English and American books on his specialty. In addition, about half the scientists also had a copy of one of Mao Tse-tung's political books.

The equipment in this institute came from all over the world. I saw a Tinsley polarograph bought in 1957; Czechoslovakian and Russian spectroscopes; a British centrifuge, super-speed MSE; and equipment, made in the institute's own factory, for measuring the electrical conductivity of soils. I was shown equipment for differential thermal analysis; a German Zeiss microscope; a superbly equipped x-ray room with Japanese, Dutch, and East German equipment; and a special laboratory for using radioactive isotopes. The factory attached to the institute had 25 workers and was used mainly for instrument repair. Although I was unable to assess the scientific merits of the research work, there was a sense of purpose and enthusiasm which marked this as a first-rate institution.

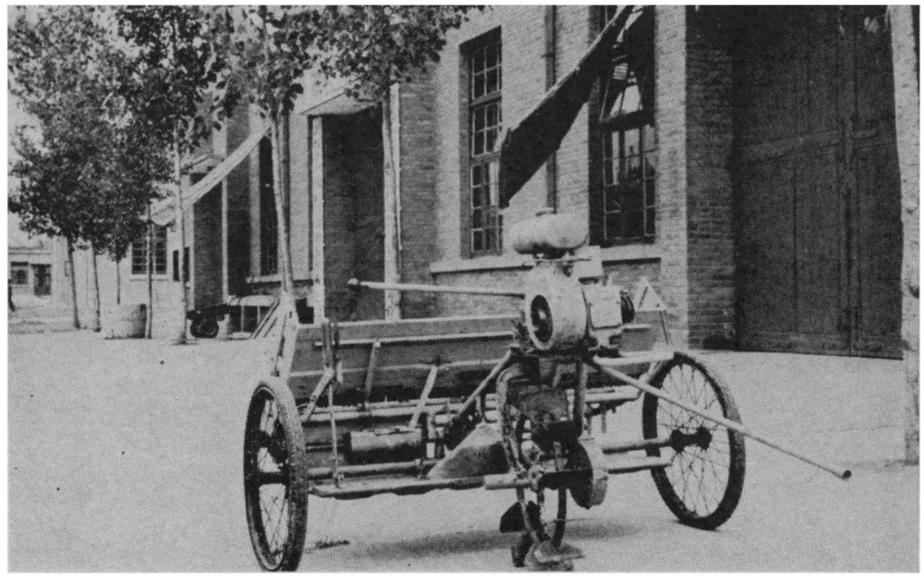

Fig. 7. The rice-seedling transplanter designed at the Agricultural Mechanization Research Institute, Nanking.

Scientific Instrument Factories

I visited two scientific instrument factories, one, in Nanking, which manufactures teaching apparatus, and the Medical Instruments Factory in Soochow. The Nanking factory produces 102 different kinds of optical and electrical apparatus. Another apparatus factory, in Wuhan, produces equipment for teaching zoology and botany, and a third, in Shenyang, makes apparatus for courses on heat and mechanics. The Nanking factory has 1400 workers and staff members and 400 machine tools; it occupies floor space of 50,000 square meters.

The manager of the factory, Jang You-shyr, stressed on several occasions that the work had been done without aid: "If there had been aid the work would have been done more quickly." In 1958, he said, the management decided to make electron microscopes and asked some visiting Czechoslovakian experts for help. The Czechs looked at the machine tools in the factory and said it was impossible; their factory in Czechoslovakia, which had many modern machine tools and expert workers, had produced only three electron microscopes in 7 years. The Chinese determined to prove they could make such microscopes, and within a year they made their first model. They have now constructed 20, and I saw another five in various stages of construction. The microscopes have a magnification of 20,000 and sell in China for 60,000 yuan ($25,000).

Fig. 8. The cable-towed plough designed at the Agricultural Mechanization Research Institute, Nanking. Here the winch on the boat is powered by an electric motor.

The Nanking factory also makes biological microscopes, metal-structure microscopes, stereoscopic microscopes, geological microscopes, slide rules, stereopantometers, astronomical telescopes, electrostatic generators, machines for studying moon and earth motion, induction coils, hand-driven generators (alternating-current and direct-current), and a variety of ammeters and voltmeters. Optical glass used to be imported from Germany but the Nanking factory now produces it.

In addition to the electron microscopes I saw the ammeter assembly room. The meters were simple but looked robust. During my month in China I visited six middle schools (three were in communes and three in cities) and each had equipment made in this factory.

The Medical Instruments Factory in Soochow makes 391 different kinds of surgical instruments, especially for gynecology, obstetrics, and eye, nose, and throat surgery. The notable feature about this factory was the way it had pulled itself up by its bootstraps. Many of the machines and processes had been built and designed by the workers themselves. For example, they themselves had made, for 40,000 yuan, equipment for a steel-tempering process which would have cost 80,000 yuan to buy. The cadres (officials) are required to spend 1 day a week in manual labor in the factory, and the department heads and the factory manager must all spend half of every day working in the factory.

To my inexperienced eye the factory seemed crude and working conditions seemed much below the standard of the Nanking factory. However, the finished products, while below Western standards, met international specifications and were exported to countries in Asia, Africa, and Latin America. The factory had won many awards for self-reliance and high standards, and the factory management, while freely admitting that they still had a long way to go to catch up with Western technology, was obviously pleased with the achievements.

My view of Chinese science was no more than a tourist's glimpse. However, I have talked to a number of scientists who visited China on the invitation of the Academia Sinica and spent their time with professional colleagues. They report that those who could speak English spoke to them quite freely in English and discussed their scientific work with complete frankness. The Chinese are the first to admit they are still a long way behind advanced world levels, but most visitors seem agreed that the scientific atmosphere was relaxed. I was impressed not so much by what has already been achieved—China is still a poor country—as by the solid educational foundation she is laying for future development.

Significant as the growth of genuine science may be, perhaps even more significant may be the efforts that are being made to bring science to the Chinese people. Caryl Haskins (*5*) has pointed out that in Britain, before the scientific revolution, people made decisions on the basis of intuition and faith. After it, they made them on the basis of reason. The consequences for the world were profound. The majority of people in the less developed parts of the world have not yet experienced a scientific revolution. They still make decisions on the basis of superstitions, faith, and intuition. During the past year I have visited many Asian countries and have discussed the problems of scientific development with the leading scientific administrators in those countries. Almost all said that one of their biggest problems was to create a science consciousness among the people. Many of these countries have first-rate scientists and scientific laboratories, but the fruits of science are not having the impact on the development of the countries that they should have. One of the main reasons for this is the unscientific attitude of the people.

One must be very cautious about overgeneralizing, but everywhere I went in China, in both city and commune, I noted a tremendous enthusiasm for science and innovation. Every commune I visited (seven in all) had its own experimental plot, and two had their own research institutes. The level of work and the standard of innovation is not high, and there is evidence that many mistakes have been made when this spirit of research and innovation has gone too far, without technical knowledge to back it up. But as the technical capability of peasants, workers, and political cadres increases, so the number of successful innovations must be expected to increase.

Everywhere I went in China I was told about the importance of combining theory with experiment. It was this constant repetition of what seems so obvious to a person schooled in the Western tradition that made me recall Haskins' words about scientific revolution. It was only after scientists such as Bacon and Newton demonstrated the importance of combining theory and experiment that the scientific revolution took place in Britain. In the old China the two were never combined; for China this is a new concept, and I believe it marks the beginning of the Chinese scientific revolution.

References and Notes

1. J. T. Wilson, "Geophysical Institutes of the U.S.S.R. and of the Peoples Republic of China," *Trans. Am. Geophys. Union* **40**, No. 1 (Mar. 1959); *Sciences in Communist China* (AAAS, Washington, D.C., 1961).
2. "Liberation" refers to the Communist victory in 1949.
3. This passage is taken verbatim from the notes I made from the interpreter's translation of Mr. Wang's speech. I apologize to Mr. Wang, and to the other Chinese who so kindly showed me around their institutions, for any errors and misquotations in this report.
4. The information on which Table 2 is based was supplied by Professor J. Miller.
5. C. P. Haskins, *The Scientific Revolution and World Politics* (Harper and Row, New York, 1964); Report of the President, Carnegie Institution of Washington (1961).
6. Table 1 is based on statistics supplied by university officials at each university during the introductory talks.