Optics and Electronics in China

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A group of ten scientists and engineers with their spouses visited the People's Republic of China in the fall of 1979 from September 16 to October 7. This visit was one of a series of exchange visits between the Institute of Electrical and Electronics Engineers (IEEE) and the Chinese Institute of Electronics (CIE). Delegates were selected from the various professional societies within the IEEE and represented a good cross section of electronics and computer technology. The author was the only one representing quantum electronics and the Optical Society. This is the third of the IEEE delegation teams to visit China since the normalization between the two nations. These exchanges are part of the transnational programs of the IEEE to establish technical relations with China for the purpose of cross-cultural exchange of technical information, to become familiar with the conditions under which the Chinese electronics engineering is practiced, and to help open avenues of improved communications between technical organizations among the two nations.

The cities that we visited within China included Canton, Hangchow, Shanghai, Nanking, Xian, and Beijing. The tour was so arranged that we could be in Beijing (Peking) during the first week of October to join the national celebration for the thirtieth anniversary of the People's Republic. Among these cities, Shanghai is by far the most industrialized, and we could have easily spent our entire trip there.

The visits to Hangchow and Xian were very relaxing. Hangchow is a resort town located about 100 miles south of Shanghai. The city is situated on the bank of the beautiful West Lake and has many hot springs along the foothills. This area is famous for its silk and Dragon-Well tea production. Xian, on the other hand, is a city of ancient culture. There are many palaces and tombs that date back to 220 B.C. In Xian we had the unique experience of observing the excavation project on one of the tombs of Emperor Chin. In this tomb some 7500 life-size soldiers and horses sculptured in clay with real chariots and bronze weapons were discovered recently. The limited air travel in and out of Xian did cause a slight delay in our schedule, but the inconvenience was more than compensated for by the extraordinary experience we gained. When we arrived in Beijing, on the eve of September 29, we were invited by Chairman Hua to be the guests at a state banquet in the People's Great Hall. This event marked one of the highlights of our trip. While in Beijing, the delegates and their spouses attended a televised reception given by the Vice Premier of Technology, Wang Tzen. Several key questions regarding future exchange programs and projects were addressed.

We were escorted during our entire trip by Mr. Qian Wenji, Deputy Secretary General of CIE, and two excellent interpreters, Mr. Tu Deyong and Ms. Wang Gindrun, workers for the Foreign Affairs of the Fourth Ministry. At each city we were entertained by our local hosts, who scheduled our technical visits and tours of local points of interest. They also made the local arrangements and accommodations for us in advance. The sites of our technical visits included a number of prestigious universities, academies of science and technology, and research institutes of electronics, semiconductors, telecommunications, and optics, as well as electronics industries. During some of the visits, delegates were selected by our local hosts to give lectures on topics of their choice. I gave a lecture on guided-wave optics at the Institute of Optics and Precision Instruments in Shanghai and on optical communications at the headquarters of CIE in Beijing. These are the only two locations where we saw lasers and optics-related research activities during our entire tour.

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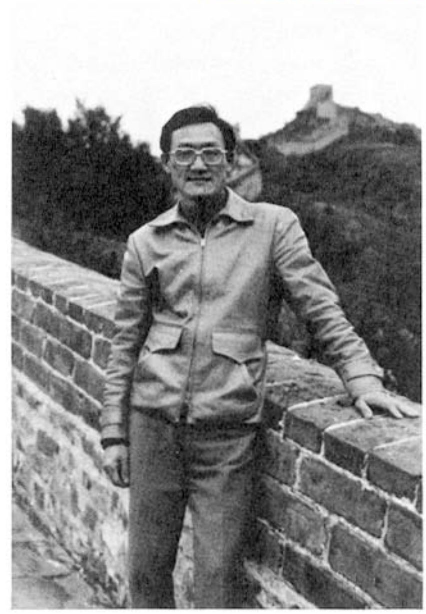

Peter Cheo at the Great Wall.

The Institute of Optics and Precision Instruments, which is under the auspices of the Academy of Science and Technology, is located in a suburb of Shanghai (about 30 miles from downtown). The Institute has a total of 1400 employees, among whom 400 are college graduates and the remainder are workers in factories affiliated with the Institute. The Director of the Institute is Mr. Ghan Fuxi, who spent only a brief moment with us. Our host at this Institute was Ms. Ho Hwei-Juan, who is the head of one of the four departments at the Institute, which are laser physics and nonlinear optics, laser devices, laser materials and components, and laser applications. At the Institute, I had the pleasure of meeting Mr. Lin Tsun-chi, who was a member of one of the first Chinese laser delegation teams that attended the International Quantum Electronics Conference held in San

Ho Hwei-Juan, head of the Nonlinear Optics Department of the Institute of Optics in Shanghai. The sign reads: "Warmest welcome, American IEEE delegation, to visit our Chinese Institute of Optics and Precision Machinery."

Francisco in 1974. Mr. Lin is now engaged in the laser-fusion program; two laboratories visited were nonlinear optics and laser fusion. It was apparent that the major effort in this Institute is in laser fusion. The laser-fusion project started at this Institute as early as 1965 and focused on the use of the Nd:glass laser to irradiate targets for the purpose of achieving inertial confinement fusion. The in-house efforts have been directed toward the production of high-quality and large-aperture glass materials suitable for the laser-amplified chains. In 1973 this Institute, for the first time, achieved a neutron yield of 1000 by using one laser beam to heat O_2. A factor-of-10 improvement was obtained in 1974 by using a mode-locked Nd:YAG laser through a chain of glass amplifiers to reach a peak power of 10^{11} W. In 1976 this facility was expanded from one beam to six beams, each of which provided a 40-J pulse for a duration of 1 nsec. The capability of this facility is not known. It is expected that the neutron yield may be of the order of 10^5. This may be compared with the present Shiva facility at Lawrence Livermore, which is capable of producing a maximum neutron yield of 3×10^{10} by using a 15-20 TW laser in a 90-psec pulse.

The work on nonlinear optics in this Institute is primarily in coherent anti-Stokes Raman spectroscopy (CARS), with applications in the areas of chemical analysis and spectroscopic studies of gaseous media. Laser systems used in these studies are the ruby and tunable dye lasers.

Almost all the equipment is made domestically and is antiquated by comparison with present-day United States standards. This seems to be one of the major handicaps that Chinese researchers are facing today. The scientists and engineers whom we met and talked with seem to be well informed on the latest technological development through readily accessible open literature. Many of our discussions dwelled on practical applications of lasers for precision measurements, diagnostics, and communications. However, one must remember that the institutes scheduled for our visits are considered to represent the best in China.

The other laser facility that we visited was at Qing Hua University. The University is located in the north end of the city of Beijing. The visit included a tour of the University library, computer and semi-conductor laboratories, and a laser laboratory, on a very large and beautiful campus. The primary purpose of the laser laboratory is the teaching of basic science and physics. In addition, this laboratory produces He-Ne, He-Cd, and CO_2 lasers for various University research programs. The laboratory appears to have well-developed technologies in glass blowing, thin-film deposition, and optical material processing. One of the most impressive lasers is the high-temperature He-Cd vapor laser utilizing a hollow-cathode discharge. The CO_2 laser technology, on the other hand, is not very advanced and is estimated to be roughly 10 years behind that of the United States.

For the most part, our visits were centered around electronics research institutes and factories. It is commonly agreed that the facilities at all the institutes are antiquated and obsolete. This is the primary reason that the Chinese electronics components yield is poor and the products are unreliable. Automation for the manufactur-

A domestically made minicomputer in operation at the Jiatong University in Xian.

The People's Great Hall at night during the thirtieth anniversary of the People's Republic of China.

The IEEE delegation at a televised reception given by Vice Premier Wang Tzen in Beijing. First row (left to right): Lu Chao Shih, Deputy Director of Foreign Affairs, Fourth Ministry; S. Yau; Liu Yin, president, CIE; S. Yau, chairman, Department of Electrical Engineering and Computer Science, Northwestern University; Vice Premier Wang; W. Spencer, director, Sandia Laboratories; G. P. Rodrique, professor, Georgia Tech; Qian Wenji, deputy secretary general, CIE; Mrs. W. Spencer. Second row: S. Shapiro, professor, Stevens Institute; Mrs. W. Porter; W. Porter, director, Institute of Solid State Electronics, Texas A&M; C. Davis, Ballistic Missile Defense Advanced Technology Center, Huntsville; Mrs. C. Davis; A. G. Milnes, professor, Carnegie Mellon University; Mrs. A. G. Milnes; Mrs. T. Weirs; T. Weirs, president, Evaluation Association. Third row: Zhon Yan, secretary of CIE; Ding Jing, Technical Information, Fourth Ministry; J. G. Linvill, chairman, Department of Electrical Engineering, Stanford University; Mrs. J. G. Linvill; the author; Chang Fooshing; Tu Deyong, Wang Guichun, and Sun Shunxing, members of the Fourth Ministry, Foreign Affairs.

ing process is virtually nonexistent. At semiconductor research institutes, we saw that the largest Si wafer size is only about 38 mm. The fabrication and testing techniques for integrated circuits resemble those used by the United States industries in the 1950's. Occasionally we observed some signs of excellence, e.g., the use of plasma etching or dry chemistry for material processing at Qing Hua University and the use of computer-aided design, ion implantation, and electron-beam writing at the Research Institute of Semi-Conductors and Devices in Beijing. These observations can only be categorized as a few anomalies.

Qing Hua and Jiaotong Universities, both of which we visited, are considered to be the most prestigious universities in science and engineering. These institutions are still in the process of revitalization from the disruptions caused by the Cultural Revolution that took place over a period of a decade from the mid-1960's to the mid-1970's. During this revolutionary period, educational programs at all institutions suffered greatly. The peak of this so-called anti-intellectual movement occurred in a period from 1968 to 1972, during which virtually all educational institutions, from kindergarten to graduate schools, came to a halt. As a result, the youth, who represent a majority of the population in China today, were deprived of education. This picture is clearly reflected at the university level, where the ratio of qualified students to faculty is about 1 to 2, and the most knowledgeable teachers and professors are in their 50's or older.

The cultural revolution also left the nation with a deep scar in its scientific and technological progress. It seems that, in order to fulfill its commitment toward modernization, China must make a major effort to upgrade the educational standards through mass media. This problem realistically is perhaps the most difficult one that China must face in the decades to come. At the Vice Premier's reception, Wang Tzen indicated that the government is doing what it can to improve the present media in order to reach more people. In regard to future exchange programs, he feels strongly that all exchanges must be based on mutual benefit and equality. In exchange for advanced technologies, China is prepared to pay with its resources, such as oil and metals, and China also intends to borrow foreign currency at a low interest rate. Foreign investment and technical visits are always welcome. On an individual basis, foreign scholars and lecturers should be reimbursed by the Chinese government for their services and technical know-how. As I walked through the city streets and talked to people at homes and restaurants, I was overwhelmed by the eagerness in the people everywhere to learn practically anything and everything for which they have been totally ignorant for so long.