Last year a delegation of international computer professionals with interests in computer science education participated in an information exchange with colleagues in the People's Republic of China. The delegation's experiences suggest that the Chinese have made substantial progress in some aspects of computer science education since late 1982, but that difficult problems remain to be solved.

JUDITH D. WILSON, ELIZABETH S. ADAMS, HELENE P. BAOUENDI, WILLIAM A. MARION and GAYLE J. YAKERBAUM

In May 1987, a delegation of computer professionals from around the world with interests in computer education were invited to participate in a three week information exchange with colleagues in the People's Republic of China (PRC). The exchange was coordinated through the People to People International Citizen Ambassador program, a non-profit organization that promotes international exchange. The invitation came from the Chinese Computer Federation who arranged the details of the exchange along with its umbrella federation, the China Association for Science and Technology (CAST).

As participants in this delegation, our objectives were to observe the current state of computer education and computer research in China, and to advise Chinese computer educators about computer education in those countries represented by delegation members. We were particularly interested in observing how the Chinese were integrating computers into the classroom and whether the differences in culture have led to different pedagogical approaches in computer education.

The delegation visited primary and middle schools as well as universities and research institutes located in Beijing, Xi'an, Hangzhou, Shanghai, Nanjing, and Guangzhou. After visiting Beijing and Xi'an, the delegation split into two smaller groups. One of these groups visited Shanghai and Hangzhou while the other visited Nanjing and Guangzhou. We describe our experiences in Beijing, Xi'an, Nanjing, and Guangzhou as members of the second group.

Meetings with Chinese computer professionals and students provided a forum for exchange. Information exchanges at the CAST facilities also took place in several cities. Additionally, our hosts provided tours of their computing facilities and demonstrations of software products they have developed for commercial and instructional uses. Tours of historical sites, visits to the homes of our hosts, and evenings left free to wander about in the cities enriched our experience of Chinese culture.

During these meetings, tours and wanderings, we experienced enigmas and contradictions. We saw enormous public buildings in cities where we knew that large families still live in one or two rooms. We ate at tables laden with dishes of meats and fish in a country...
where population control is a major issue due to the difficulty of feeding the people. We saw image processing and talked of artificial intelligence in a country where most people must bicycle or walk wherever they go. We rode in modern, air-conditioned buses which acted as threshing machines by riding over wheat put down in the road by farmers. We saw a culture that had traditionally revered its elders, now focus its attention on its children. We saw glossy, beautifully photographed pictorial catalogs describing universities where there was no money to buy books. We encountered people, who for years had been taught to view outsiders as foreign devils, behave in openly curious, friendly and extremely kind and helpful manners.

Although it may be risky to extract global significance from a small set of localized, often enigmatic observations, we consider here what our experiences can tell us about computer education in China in the late-1980s. Our discussion focuses on computer science education in universities and research institutes.

**COMPUTER EDUCATION IN CHINA**

Schools and universities have been at the center of political events in China since 1949 and the development of computer education should be understood against this political background. The Beijing Institute of Computer Technology was established in 1956 as part of a 12-year plan for the development of science and technology [17]. Professional computer studies were established during the next few years at Tsinghua and Beijing Universities and a first-generation computer was completed in 1958 at the Beijing Institute. During this period, the Soviet Union was China's main contact with the outside world.

By 1960, China had broken off relations with the Soviet Union, and in the years that followed became more isolated from the rest of the world and lagged further behind the Soviet Union and the United States in the development of computer technology. The chaotic years of the Cultural Revolution (1966 to 1976) brought computer education to a standstill with the closing of universities and many secondary schools. Intellectualism was discouraged, ideas from the outside world were considered dangerous, and thousands of teachers were sent to the countryside to work with their hands. Professor Su Yun-Lin, Vice-Chairman of the Computer Science Department at Jinan University in Guangzhou, explained that he had been criticized by the authorities in 1972 for translating and publishing the ACM Curriculum '68. Jinan University was closed down from 1970 to 1978 [10]. Although computer education suffered during this decade, electronic and computer industries were given special priorities and protection in the interest of national defense and China built several second-generation and a third-generation computer by the early 1970s [17].

In 1975, as the revolutionary fervor of the Cultural Revolution was subsiding and some of China's more pragmatic leaders regained control, Premier Chou En-lai enunciated a program that has become known as the “Four Modernizations” program. The purpose of this program was to elevate China to the status of a world power by the year 2000, with sweeping reforms in the four areas of agriculture, industry, defense, and science and technology [10]. Within a few years it became clear that if such advancement was to take place, the Chinese would have to improve their educational system dramatically.

While computer courses have existed since the late 1950s and early 1960s in Chinese universities, computer science departments were first established in the mid-1970s. By 1982, computer science departments had been established in 100 universities. Currently, the computer science curriculum in many of China's universities, including those we visited, is based on ACM Curriculum '78 guidelines as well as on the dicta and policies of the Chinese higher authorities [24].

The chaotic years of the Cultural Revolution (1966 to 1976) brought computer education to a standstill with the closing of universities and many secondary schools.

In 1985, the Chinese Computer Federation was founded to develop and promote computer science and technology in China [2]. The federation has sponsored numerous national and international computer conferences since 1985. It has established relations with many international organizations and now has eight national and international publications, including the English language Journal of Computer Science and Technology [11]. The federation set up a special computer education team to design specific courses and teaching programs, and to establish subject matter. One consequence of this effort has been the identification of three different computer education tracks: technical training, computer non-professional education, and computer professional education, which is the primary concern of computer science programs in the universities and research institutes we visited.

Computer science was formally recognized as a scientific discipline with the founding of the Chinese Computer Federation and its inclusion within the China Association of Science and Technology (CAST), a federation of more than 100 national organizations of scientists, engineers and technicians. This recognition has opened the way to new commitments in funding and program development at high levels in the central government, including a commitment to facilitating information exchanges between Chinese computer professionals and their international counterparts.

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1 We understand that many Chinese universities use the IEEE Computer Society Model Curriculum although we did not observe this ourselves.
UNIVERSITIES AND GRADUATE RESEARCH INSTITUTES

Our observations about universities and research institutes in China are based on visits to the institutions listed in Table I. All of these institutions are among 85 to 100 key institutions, designated as such by the Chinese Ministry of Education on the basis of past excellence in research and education. They are ranked within this classification. Key institutions receive a large proportion of the state resources allocated to higher education with the higher-ranked institutions receiving the most support. The institutions we visited were perhaps among the top 20, with Beijing and Tsinghua Universities ranked as the top two.

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<th>TABLE I. Cities and Institutions Visited by the Delegation</th>
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<td>Beijing: The China International Conference Center for Science and Technology</td>
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<td>Tsinghua University</td>
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<td>The Beijing Guangdong Chinese Computer Institute</td>
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<td>Jinan University</td>
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Traditionally, higher education in China has been a privilege enjoyed by a small number of Chinese. The number of colleges and universities has grown from 205 in 1952 to 902 in 1984. Student enrollment grew during that time to approximately 1.4 million with 23,200 graduate students and 500 doctoral candidates by 1985 [5, 13]. Although these numbers may appear large, they imply that only about 0.1 percent of the population receives a college education.

Admission to undergraduate and graduate programs at universities and institutes is highly competitive and is based primarily on ranked scores on national examinations. Undergraduate applicants may select a number of institutions for which they believe they would be qualified before learning their scores on the national examination. Students whose scores are too low for consideration by any of their chosen schools are usually not admitted into a university, although re-evaluation is sometimes possible after first assignments have been made.

According to 1985 statistics for the computer professional education track in Chinese universities, there are over 50 departments providing graduate studies, over 220 providing undergraduate studies and 86 providing two-year undergraduate studies programs [23].

Facilities

The universities occupy some of the most attractive environments in China's cities. Most of the buildings are old, by our standards. Those at Beijing University, for example, are several hundred years old and were once used by the Ming emperors for other purposes. The computer facilities at Beijing University are located in one of these ornate buildings and include modern equipment protected by glass walls through which one can see the exquisitely colored terracotta walls and ceilings of the Ming Dynasty.

The computer facilities at Beijing University are located in one of these ornate buildings and include modern equipment protected by glass walls through which one can see the exquisitely colored terracotta walls and ceilings of the Ming Dynasty.

Every university the delegation visited maintains beautiful gardens, many with small lakes, pagodas, islands and tree-lined paths which encourage tranquil walks and quiet reflection. In contrast, the interiors of the buildings are generally austere, with high ceilings and dim lighting. Although computer centers are often quite small and located in centuries-old buildings, they are air conditioned. In contrast, other rooms are cooled only by thick walls and high ceiling fans. Despite the absence of modern surroundings, facilities are well run. In several locations, we were required to wear rubber soled sandals while touring computer facilities. This was particularly important in cities, such as Beijing and Xi'an, where massive city-wide construction projects continually fill the air with a fine powder of dust and debris.

Most of the universities we visited owned a mainframe and/or one or more minicomputers (VAX 11/750 and 11/780 models were relatively common) and a large number of microcomputers. Tsinghua University, for example, has a computer center with an M50, a DPS8 and a Honeywell flexi 6400 as well as a VAX PDP/VM and 600 microcomputers. At the East China Institute of Technology in Nanjing, we visited a computer graphics laboratory and a computer center equipped with 600 microcomputers, a Japanese MV/8000, a Japanese Mini-Eclipse with 24 terminals, an Image Processing System, and a Mini-CAD system with CPU 68010.

Although the Chinese have made considerable progress in developing their own computing machines and software, and in obtaining equipment from abroad, the computer professionals we met pointed out that the lack of up-to-date hardware, reliable software, and adequate documentation, is still a significant problem in China. Chinese universities have difficulty obtaining adequate computing equipment for several reasons. One reason is that American firms have not yet set up computer manufacturing plants in China which would lower the cost of hardware. U.S. manufacturers have found that "China suffers from lots of problems that make manufacturing an unattractive venture" [6]. With
the unfavorable foreign exchange rate slowing computer purchases from the Western world and Japan, Chinese universities continue to have difficulties obtaining hardware. Discussions with computer educators, however, revealed they are more discontented with outdated software than with hardware. This situation is exacerbated by the fact that, to date, the United States and China have no official copyright agreement. Until the time that such an agreement is signed, we expect China to suffer from a shortage of up-to-date software as well as a shortage of research and trade journals and textbooks.

The Chinese are no longer completely dependent on imported computing equipment, however. In Guangzhou, our delegation visited the Beijing Guangdong Chinese Computer Center which is a research and development center jointly organized by the Institute of Computing Technology of the Chinese Academy of Sciences, the Computing Center of the Ministry of Finance, and the Institute of Computing Technology Application of Guangdong Province. The center is involved in research and development of computers and has designed and produced the GF20 ("Great Wall") series of Chinese microcomputers. The center has done work in the areas of distributed microcomputer systems, local area networks, intelligent printers, controllers, and intelligent Chinese language terminals. It is also involved in computer applications, and in marketing and servicing the computers it manufactures.

Curriculum

The majority of universities offer four year programs of study at the undergraduate level, although a few, including Tsinghua University, offer five year programs. It normally takes two to three years beyond the undergraduate degree to complete a master's degree and three to five and one-half years more to obtain a Ph.D. in computer science. A master's degree requires a thesis based on original research. Specific professors are designated by the Ministry of Education as eligible to accept graduate students at either the Masters or Doctoral level, or both. There are very few computer science Ph.D. programs at the present time. Several computer educators expressed great interest in seeking government support for more graduate programs in computer science.

As noted previously, a large number of computer science programs follow the ACM Curriculum '78 guidelines closely. Keeping pace with the level of computer science education in U.S. universities is a major goal. Computer science professors in the universities we visited described courses that are found in college catalogs in the U.S., but there were some curriculum variations across different types of institutions. We will briefly describe the computer science curricula in two different institutions: the South China Institute of Technology and Jinan University. These facilities are representative of two different types of computer science programs in China.

The curriculum at the South China Institute of Technology (SCIT) in Guangzhou serves as an example of undergraduate computer science curricula in the key Chinese technical universities visited by the delegation. The SCIT is one of the major science and technology universities in China. It has 14 departments, more than 10,000 students and 2,000 faculty members. The Department of Computer Science and Engineering has 400 students and 48 faculty members. The school year is divided into two 20-week terms. The curriculum for the first three years of the four-year undergraduate program is fixed and includes courses in Fortran and C programming, digital logic, principles and applications of microcomputers, organization of computer systems and characteristics of industry control computers as well as the standard ACM recommended core courses [1]. In the fourth year, undergraduates may elect to take graduate courses in software engineering, multiprocessor systems and parallel processing, information processing in Chinese, multivalued logic, and computer system performance evaluation, among others.

Jinan University is "primarily committed to satisfying the needs of overseas Chinese students", including students from Macao and Hong Kong [10, p. 17]. The computer science undergraduate program adheres closely to Curriculum '78 guidelines, but computer science students take a range of courses in addition to their technical load, including courses in the Communist Party; History of Modern China; History of Chinese Science and Technology; and Philosophy. In their last year, computer science students have the option of taking Decision Support Systems, Analysis and Design of Information Systems, Networking and Software Engineering.

The ACM delegation to China in 1982 explained the poor quality of computer science education in Chinese universities was due to a lack of facilities, a lack of teachers, and a lack of incentives. Our delegation also found that growth in computer education and research has been hindered by a lack of adequate hardware and reliable software.

Jinan University has only a Master's program at the graduate level. Graduate students can choose from four options in graduate study: software engineering; distributed database design; software methodology; and artificial intelligence applications. Due to a shortage of qualified faculty, some of the graduates of this program are retained by the computer science faculty [24]. The tendency in Chinese universities to retain their students as faculty members has been attributed by Maier to a system of "inbreeding," rather than need [13].
generally, computer research projects in technical universities and graduate research institutes have immediate applications. this is certainly due to the allocation of resources for research which is determined by policy decisions at high levels within the central government. at tsinghua university, for example, 75 percent of financial resources for scientific research in 1984 were channeled to key projects for the five-year plans and to applied research and development programs in industry [19]. for xian jiaotong university, an emphasis on applied research is a matter of policy: “in scientific research the university adheres to the policy that . . . science and technology should serve economic construction.” [21]

at xian jiaotong university much work is being done in computer-aided instruction. we were shown acai software package for “electromagnetic field” and “electromagnetic field and wave” courses. this system, written in extended basic, is for the purpose of helping students review and master the concepts and techniques introduced in these courses [12, appendix g].

the computer science department at beijing university, which awards 25 graduate degrees each year, draws its faculty from electronics, physics and mathematics. the research faculty includes two full and 12 associate professors with research interests in software engineering, graphics, networks, artificial intelligence, distributed systems, architecture and theoretical computer science. however, the research program is heavily contracted with industry and with a “national science foundation” that sponsors projects under the current five-year plan (1986-1990) in meteorological graphics, distributed systems, networks and medical applications, among others.

the beijing guangdong chinese computer institute in guangzhou (bgc) has a well-organized research, development and production program including the development of both hardware and software systems. as noted earlier, bgc hardware includes a full line of gf20 microcomputers with chinese and english compatible control and applications software. bgc-designed software includes a three-dimensional chinese character spread sheet (“gcrs”) and a combination of dbase-ii and gcrs for the gf20/11a microcomputer (“ctbase”). applications software ranges from a stock management system to a chinese recipe system which maintains a database of recipes that can be displayed in english and chinese.

the applied emphasis of computer research in chinese universities and institutes quickly became apparent in our information exchanges. most of the questions the chinese asked our delegation had to do with solving immediate practical problems. a group of computer engineers at scit, for example, surprised delegates with their interest in software for the administration of universities and middle schools. on several occasions, we were able to refer our hosts to colleagues at chinese institutions in other cities who had solved similar problems. this indicated a lack of communication among chinese computer scientists which may dis-
appears as more international computer conferences are held in China, and as international network connections are established.

Chinese educators and researchers agreed that their greatest immediate problem is isolation from the international computing community. This isolation would be reduced by quicker access to important foreign journals, conference proceedings, and advanced textbooks, as well as better and more rapid translations of foreign language articles. It would be reduced more effectively, however, if the next generation of computer and information sciences faculty gains experience abroad. Chinese leaders with whom we met hoped to accelerate the development of computing education and research in China by sending their best graduate students and some faculty for graduate study abroad, particularly to the U.S.

THE SOCIAL AND CULTURAL CONTEXT

Recent Trends in Pre-University Computer Education

Our delegation visited several primary and middle schools which offer pilot computer education programs or extra-curricular computer activities. These schools have received the additional government and industry resources and encouragement needed to develop such programs with the hope that they will serve as models for computer education in the rest of China [3].

Most pre-university experimental schools are located in major cities and are affiliated with universities, institutes and enterprises, such as the Far Eastern Machinery Manufacturing Company in Xi'an. However, a few such schools are located in smaller, more remote regions, such as Shaoguan City in northern Guangdong Province [15]. In general, these schools make do with minimal computing resources. Equipment, such as television monitors, is obtained from wherever it can be found and modified for use in microcomputer laboratories. Commonly, a few microcomputers, or a single machine, are operated for long hours through the week, and shared by many students for short periods of time each.

A competitive ethos has been cultivated among young programming students in these schools during the past several years. Programming competitions are held at local, provincial and national levels with only very few winners from each level allowed to participate at the next higher level. Competition entries at the highest level, the National Teenager's Computer Programming Competition [2], are evaluated on practical and innovative criteria as well as technical excellence. Since these entries often have practical and technical applications in education and management, they are sometimes adopted for use in schools, businesses or industries. Winners of competitions at the highest level may be accepted early at prestigious universities and are recipients of other honours as well.

Preparation for such contests begins months in advance, and some schools invite outside computer experts to help in the training. In some cases, extra-curricular student organizations have been formed to select and train the most gifted competitors. At the Shaoguan middle school, for example, where all computing activities are extra-curricular, talented students who have the ability to study independently and creatively are invited to be members of "the team for raising the standards" [15]. Especially gifted elementary school students are also invited to join the team. Team members are intensively trained for computer competitions, and the most talented are given special opportunities and encouraged to surpass their own teammates.

The competitiveness which we observed in the primary and middle schools has been a part of Chinese culture for centuries. The prestigious position of civil servant, for example, could be gained only by passing demanding examinations, whose difficulty increased with the level of the position (local, regional, and imperial). The competitiveness which we saw in the schools has been channeled effectively from other cultural institutions to computer education.

It is well known that China under Mao has officially proclaimed the equality of women and has provided professional opportunities for women unparalleled in its history. Thus, we were surprised to find that only a small percentage of computing professionals in China are women.

One of the consequences of this competitiveness in the primary and secondary schools is increased interest in computer technology among students, and increased support of computing activities by parents as well as by local and provincial governments [2, 8]. Student interest in these competitions may be further evidence of a growing independence among pre-university school children in China which has been noted elsewhere [20]. Trends in computer education at these experimental primary and middle schools in China hint at future directions in computer science education in Chinese universities and research institutes. In particular, these trends suggest there will be a greater emphasis on independent initiative and creativity than has been observed in the past [4].

The Participation of Women in Computing

It is well known that China under Mao has officially proclaimed the equality of women and has provided professional opportunities for women unparalleled in its history. Thus, we were surprised to find that only a small percentage of computing professionals in China are women. A few of the professors, translators, graduate students, computer center staff and primary and secondary school administrators we met were women. However, none of the chairs of computer science departments, none of the university officials, and none of the officers of the various associations of science and technology who met with us were women. Xia
Shaowei, a full professor in the Department of Automation at Tsinghua University told us, when asked, that only seven of 200 full professors at Tsinghua University are women.

We were informed that only 10 percent of the contestants at the prestigious national Teenagers' Computer Programming Competition are women. and that in general, one third of the students in computer classes in middle schools are female. We observed only a small number of female students in the computer laboratories for middle school children (aged 11 to 16 years) which we visited. These included the computer clubs for the Chinese youths at Computerland Training School in Beijing. It was explained to us that this is due to the "natural" choice of the women. Along the same lines, Wang Benshong, a Beijing middle school principal, is reported to have said that girls are less interested in computers than are boys [22].

On one occasion we were informed that the small number of women in university computer science programs can be explained by the fact that boys perform better than girls in the national examinations and competitions which determine admission to universities. However, it has also been reported that "female under-representation at the level of tertiary education is partly due to the fact that universities often directly discriminate against them by demanding a higher entrance exam score from the girls than from the boys" [10]. Discrimination in university admissions coupled with a male bias in the commercial and industrial job market [9, 14] may effectively discourage female students from participating in scientific and technical activities in the primary and middle schools. The experience at Beijing's Gucheng No. 2 primary school, however, suggests that young girls can be as interested in the computer as boys and that teachers are willing to cultivate this interest. As one of the school's successful programming teachers explains, "The key is to start early" [22].

Social Status and Economic Conditions
Since the end of the Cultural Revolution in 1976 and the official recognition of computer science as a scientific discipline in 1985, Chinese computer professionals have won increased social and intellectual status. In Beijing, members of our delegation had an opportunity to visit the homes of Computer Science Department professors and administrators in the best of China's key universities. We were told that living conditions for university faculty have improved dramatically in the last few years, and many whose homes we visited had recently moved into their apartments.

In general, housing in Beijing is scarce with many young couples living in the already crowded quarters of their parents. An alternative to the problem of finding a place to live is to find a job with a company or organization that provides housing. The homes we visited were in new apartment buildings built for university personnel.

Our hosts seemed proud of their apartments and belongings. They welcomed us graciously into their homes and happily shared what they had with us. It would seem that economic conditions have improved for computer science faculty within the past four years [4, p. 213].

Professional Life and Conduct
Our experiences with our counterparts and their students in China were conditioned by whether our meetings were organized around groups or permitted one-on-one contacts. More formal exchanges were conducted through designated group leaders, usually university or departmental administrators. Contributions from other group members were typically invited by the group leader, and students rarely spoke. Clearly, the comportment of these meetings had been planned in detail by the group leadership.

In contrast, junior faculty and graduate students were willing, even eager to discuss more personal and sensitive matters in small informal groups. During these informal discussions, students spoke of limited resources and political restrictions on opportunities to study abroad, while faculty spoke of dependence on political funding for resources and on high-level political decisions to expand, restrict or eliminate academic programs. It was clear that decisions about program support, research direction and even individual career options originate with and flow downward from the Ministry of Education and the National Planning Committee. However, we encountered little apparent frustration, resentment or anger about this on the part of Chinese academics. In this respect, Chinese cultural traditions seem to mesh with the decision structures of the current political regime, and China's new policy of openness seems to be developing within well-established lines of communication and decision-making.

Professional exchanges invariably began with introductory remarks by group leaders and introductions of attendees. These were often followed by several presentations by members of our delegation and at least one presentation by a Chinese group leader. All visits included a tour of computing facilities or classroom laboratories, and often included question and answer sessions during which members of our delegation would exchange information with our Chinese hosts. Presenters typically worked through translators who had a good command of English, and who were reasonably knowledgeable about computing terminology and issues. Often, computer science professors or graduate students served as translators. In addition, copies of technical papers, presentation abstracts and delegate professional biographies (including research interests and backgrounds) had been forwarded to the Chinese Computer Federation months in advance of our arrival.

In spite of these arrangements, invited presentations were often met with respectful silence, and, in some cases, question sessions had virtually no connection with our collective areas of expertise. Perplexed and frustrated by these puzzling incidents, delegation
members considered several explanations, including the following:

1. It is possible that papers and talks by delegation members were not well-understood. It is unlikely that this could have been a language problem. Instead, it may have indicated that the Chinese have different interpretations (understandings) of research questions, or that they have different loci of research interest.

2. The Chinese did not appear to define their research interests within a broad theoretical research context. Instead, their interests were concerned with hardware, end-user interfaces (graphics, character set translation), and system software, particularly software needed to solve networking and distributed processing problems. Our experiences suggest that, in general, computer science research in China is directed toward satisfying immediate needs, and this insularity is reinforced by difficulties the Chinese have obtaining foreign journals.

3. Complete information about the delegation apparently was not forwarded to all institutions we visited, particularly those in cities other than Beijing. This suggests that information sometimes flows sparingly from central authorities or organizers of CAST.

4. Differences in response to our delegation also may have reflected differences among the institutions we visited. The most stimulating exchanges occurred in situations where attendees included students and faculty from the top key universities in China. The Chinese at the local level seemed primarily interested in showing off their educational programs and equipment.

5. A silent response may be a sign of respect for the Chinese, however unnerving it may be for us.

During more formal scientific exchanges the tension and competitiveness often experienced in our own academic settings seemed absent. Relationships between faculty and students were supportive and encouraging; professors were obviously proud of their better students, and in some cases included students in informal social gatherings involving members of our delegation. Concern for students was also expressed at a professional exchange in Nanjing, where a young teacher asked several questions about effective ways to stimulate students in the university classroom. The students with whom we spoke shared their professors’ optimism about the effort to develop computer science and computer education in China. They appeared to view this development as a largely cooperative venture, even though competition at all levels is fundamental to its success.

SUMMARY AND CONCLUSIONS

Computer science education has progressed rapidly in the past several years in China’s top universities and research institutes, as has the social and economic status of computing professionals. This progress must be attributed in part to the official recognition of computer science as a scientific discipline with the formation of the Chinese Computer Federation in the mid-1980s, and the subsequent expansion of government support for new educational programs, facilities and research. The CCF has been effective in implementing China’s new policy of openness by sponsoring international computer conferences in China and making a high-quality Chinese computing journal available to the international community.

More subtle progress in computer science education is indicated by recent trends in select primary and middle schools. The emphasis on competition in these schools suggests that independence and initiative will become more common among future computer science students. Moreover, successful attempts to interest young females in computers in the primary schools should eventually increase the participation of women at all levels of China’s computing enterprise.

The Chinese are a proud people with values rooted in an ancient history and culture. In the past two centuries, their contact with Western culture has not been a very happy one. Yet, as one of our European delegates observed, the Chinese with whom we came in contact appear to admire the West, especially the Americans, for the technological advances that have been made. They want to learn as much as they can about the United States and its culture and people, and they genuinely want to develop friendships with Americans.
There have been periods when the Chinese have attempted to modernize, or "catch up" with the West, but these attempts have always been thwarted by cultural upheaval or war. In China today, there appears to be real tension between those who wish to modernize by borrowing ideas from the West (such as private capital and labor) and by cooperating with the West on joint technological and economic ventures; and those who fear that such ideas and cooperation will lead China away from the path of socialism and Maoist doctrines. Beneath this tension, however, there is something more fundamental operating. For millennia the Chinese have believed themselves and their culture superior to all others and have viewed China as the "central country" in the world. This view has held despite the fact that during most of the past 200 years China has been at war and, for some of that time, has been dominated by foreigners and "barbarians" [7]. The real challenge for the Chinese, then, will be to steer a path toward economic and technological modernization which allows them to maintain their ancient culture and their dignity as a nation.

Given the historical problems China has faced, the progress that we observed in computer education was impressive. We witnessed the results of incredible resolve. We met people who asked questions politely but determinedly about what they feel they want and need to know. We were met with courtesy and warmth and curiosity. If what the Chinese learn from their foreign visitors is commensurate with the effort they put into learning, it will not be very much longer before they are able to move forward on their own and we will be learning from them as they learn from us.

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8. Guangzhou Municipal Education Bureau. The outline of computer education in primary and middle schools in Guangzhou. Presentation by Mr. Zhao, Department Director, May 28, 1987. (Published in [12], Appendix I.)


Information available from the ACM Order Dept. 1-800/342-6626 (in Maryland, Alaska or Canada, call (301) 528-4261).