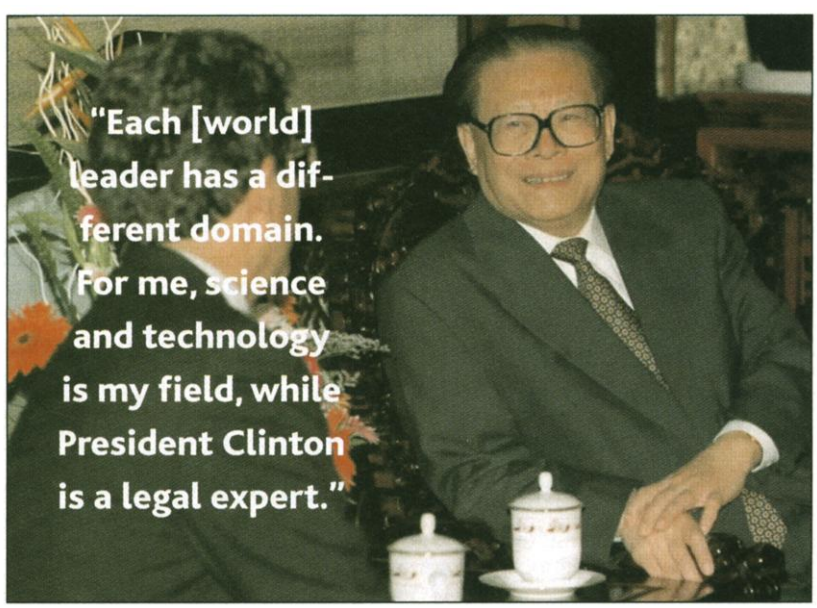
In an exclusive interview with *Science*, President Jiang Zemin offers a glimpse of a new China that is encouraging young scientists to use the Internet for their work—and reveals his secret past as a nuclear engineer

China's Leader Commits to Basic Research, Global Science

BEIJING—The specially numbered car was waved through the western gate and entered an enormous compound that, not so long ago, for security reasons didn't appear on city maps. But residents have always known where it was, and some have now dubbed it the New Imperial Palace. Nestled against the western wall of the Forbidden City and a short walk from Tiananmen Square, the compound is the home of China's central government. It is a sprawling, scenic, lakeside expanse of small buildings, with ornately carved temple roofs, mahogany furniture, and golden cushions. It was in one of these buildings that the president of China, Jiang Zemin, greeted *Science* on the afternoon of 17 May for what in the guise of a friendly conversation proved to be a unique interview—an exchange that lasted just short of 2 hours.

Jiang is a man of contrasts as striking as those of the nation he leads. He studied civil engineering in secondary school and power engineering at university. After graduation, Jiang worked as a mechanic on the power equipment of a food processing factory in Shanghai. After the founding of the New China, he was put in charge of the factory. During the Kuomintang's bombing of the Shanghai Power Plant in 1950, Jiang personally started the standby parallel diesel power generating sets to keep the ice cream in the factory from melting, a feat of which he is very proud. Later, he served as director of the Power Plant of the Auto Works in Changchun—the first auto works in China—chief engineer of Shanghai Electrical Machinery Research Institute, and director of China Nuclear Power Research Institute. The last will be news to most Chinese, because even today Jiang's curriculum vita refers to the facility by its code name: the Wuhan Heat and Power Machinery Research Institute.

All these accomplishments didn't exempt Jiang from attacks during the Cultural Revolution, however. But his rise to power continued after that chaotic period, first as vice chair of the State Administration for Import and Export, then as minister of the Electronics Industry, and next as mayor of Shanghai. At age 73, he demonstrates a broad range of interests—recounting history and citing Western novels from *Madame Bovary* to *Gone With the Wind*. He is fond of quoting Chinese poets, Confucius, and the Gettysburg Address, and refers frequently to his "research in the archives."



Up close. Chinese President Jiang Zemin offers *Science* Editor Ellis Rubinstein his personal views on Western literature, Chinese history, the U.S. as a melting pot ... and, oh yes, science.

A protégé of the former Chinese leader Deng Xiaoping, Jiang has learned to show a multiplicity of faces. In his meeting with *Science*, he was alternatively tough, charming, charismatic, personally warm, and somewhat rambling yet clear on what he wanted to say and what he didn't. And although some observers saw him as a colorless bureaucrat and an intellectual lightweight when he succeeded Deng, Jiang makes clear in this interview with *Science* Editor Ellis Rubinstein that he is a pragmatist and is committed to major structural change. His comments are edited for brevity and include written answers to questions submitted prior to the interview.

Science: *Compared to the leaders of Western nations, China's government leaders are far more likely to be engineers—like yourself—or scientists. What is your view of the importance of science and technology to the national well-being?*

Jiang: People in China attach great importance to science and technology. China had a long history with splendid achievements in science and technology. But starting from the last years of the Ming dynasty, it began to lag behind other countries in terms of science and technology. From Newton's dynamics, to Einstein's theory of relativity, to the latest development of the Internet, science and technology has developed by leaps and bounds. So I often ask myself why China began to lag behind.

Generally speaking, the reason lies with the feudal system in China. In the Ming dynasty, the Great Wall was renovated and strengthened. The feudal rulers forbade traveling abroad and later imposed restrictions on entry into and exit from China via sea. That closed the door to external exchanges between China and the rest of the world.

You must have noticed that many Chinese leaders—Li Peng, Zhu Rongji, and myself—used to be electrical engineers. And many other Chinese leaders also have an engineering background. That is because we all wished to build up our country and rejuvenate our nation by relying on science and technology when we were young.

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International cooperation

Science: *Now China appears to be opening up rapidly, particularly in science. What are some of the promises and perils of opening up?*

Jiang: Fifteen years ago I was mayor of Shanghai, and recently I visited Shanghai again. I was surprised to see so many achievements in housing construction, public transport, commodities supply, and information infrastructure. And all this has come as a result of reform and opening up. Therefore, I've always believed that we need to cast aside ... bad legacies [such as closing our borders. And yet] we still need to ... promote all the fine traditions of the Chinese civilization.

Recently, I paid a visit to Greece. I had begun to develop a strong interest in Greek civilization back in middle school days. Therefore, during the visit I discussed with people the comparative studies of the Eastern and Western cultures and the theories and principles advanced by Socrates, Plato, Aristotle, Archimedes, and others. My point is that, on the one hand, the Chinese people have every reason to be proud of their ancient tradition of civilization, but, on the other hand, we should not stop learning—not even for a single day—from all the fine traditions of the world.

Science: *What are the practical consequences of this philosophy?*

Jiang: China has signed agreements on scientific cooperation with the governments of 95 countries and established scientific links with more than 150 countries and regions. Chinese scientists have participated in 800 scientific collaboration projects launched by international organizations. As long as we follow the principles of equality, mutual benefit, sharing achievements, and respecting intellectual property rights, there should be no risks involved. On the contrary, international collaborations, exchanges of scientists, and the sharing of resources and information and research instruments will help advance science, promote economic and trade cooperation, and propel economic globalization.

Confucius once said that whenever there are three people walking together, one of them is bound to be able to teach you something. And Confucius also said that to say what you know and what you don't know is knowledge. Through international cooperation, the Chinese scientific community has learned modern theory and management expertise, upgraded research and development capabilities, improved engineering and product quality, and produced good economic and social results. At the same time, Chinese scientists have made great contributions to modern scientific progress.

Science: *What new initiatives best show China's commitment to international scientific collaboration?*

Jiang: The Chinese government will, for example, fully support the development of worldwide and cross-region cooperation networks of scientific research and high-tech industries, such as setting up Sino-Israeli, Sino-Australian, and China-APEC [Asia-Pacific Economic Cooperation] scientific collaboration funds. Moreover, we encourage Chinese scientists to participate in the Fifth Research Framework of the European Union and in other major international collaborations on a selective basis. Meanwhile, some state-level scientific programs and research centers are open to foreign research institutions and scientists who are welcome to participate in our basic research and high-tech programs.

China's research capacity

Science: *Can China afford to build its own large research facilities, or can it gain the necessary benefits from international collaborations with other countries?*

Jiang: Yes, we have put the construction of large research facilities high on the agenda to propel scientific advances. In recent years, we have built a number of large research facilities, such as the Beijing Electron-Positron Collider, Lanzhou Heavy Ion Accelerator, Hefei Tokamak Facility, and Qinghua Low-Temperature Nuclear Reactor, all of which have enhanced our research capability and broadened our capacity to probe the unexplored world. Large research facilities that are still under construction include the Diastrophism Monitoring Network [to measure movement of Earth's crust], the Large Area Multitarget Optical Fiber Spectroscopic Telescope, the Cooling Storage Ring of Lanzhou Heavy Ion Accelerator, and the Hefei Superconduction Tokamak Facility. The Chinese government will intensify its efforts for the construction of such facilities in the Tenth Five-Year Plan to improve the country's basic research capabilities. International collaboration is crucial to scientific advances and benefits all the participants. We hope to expand the channels for scientific collaboration with other countries and take an active part in international collaborations with large research facilities.

"We know that the outcome of basic research has been tremendous breakthroughs and progress for the entire human society. ... In fact, the continuing advance in applied research will inevitably demand further development in basic research."

Science: *What are your feelings about basic versus applied research?*

Jiang: Looking at the history of science and technology development, we know that the outcome of basic research has been tremendous breakthroughs and progress for the entire human society. And basic research has promoted progress in applied research. In fact, the continuing advance in applied research will inevitably demand further development in basic research.

I dare to say that without quantum theory, there would be no microelectronics technology and, likewise, without relativity theory, there would be no nuclear bombs, nor would there be any nuclear power stations. Sometimes people may not know in what specific areas a breakthrough in basic research may be applied. The scientists who had established quantum theory would not have been able to predict how microelectronics technology would develop. So I have been telling people that our efforts should be rationally divided between basic research, applied research, and the development of technologies.

Of course, one has to consider the level of economic development and the realities of an individual country. Personally, I hope that an economically strong country like the United States will give more input to basic research.

Science: *What new initiatives best show China's commitment to fostering basic research*?

Jiang: The state has kept appropriating more funds for basic research. We held another national conference on basic research last March and discussed how to create a more favorable research environment for scientists. We encourage scientists to choose research subjects on their own, and we encourage research institutes to adopt new mechanisms that foster scientific development. The government will continue to increase investment in basic research and encourage the relevant agencies, local govern-

ments, enterprises, and the private sector to support basic research in various ways.

Science: *What fields of scientific research do you feel are most likely to provide high payoffs for China's future well-being?*

Jiang: Research results in many new interdisciplinary areas may significantly influence China's future well-being. Personally, I think information science, life science, materials science, and resources and environmental studies will be crucial to China's sustained development in the future.

Scientific exchanges

Science: *Of all the changes taking place in China, none may be more future-oriented than the new efforts by your administration to bring young people back from the United States and from Europe and to provide them with important positions. Are you personally supporting China's new policies?*

Jiang: It is our policy to ensure [scientists and engineers] the freedom to come and go—to travel abroad and to come back to work here in the motherland. Despite all the different views, we still believe that they should have the freedom to come and go. And we need to further develop the Chinese economy and create better conditions to attract more people back.

Science: *Many in the West think that China's young people are unable to freely engage in Internet discussions with their peers outside China and are limited in their ability to travel freely. Is that true?*

Jiang: I'm sorry that [people would have such a] presumption, [because it is] not reality. In recent years, China's young people are not only free to discuss on the Internet but also have many opportunities to go abroad for study or work. Between 1978 and 1999, nearly 320,000 Chinese students and scholars went abroad to study. The number more than doubled that from 1872 to 1978 (about 130,000). Over the past 20 years of reform and opening up, China has received more than 340,000 students and scholars from 160 countries and regions.

Moreover, the Chinese government has since 1993 implemented the policy of supporting scholars to study abroad, encouraging them to return, and ensuring them the freedom to come and go. Last year, we issued a regulation on the management of intermediate agencies for self-funded students who intend to study abroad. All this has facilitated both government-funded and self-supported students to study abroad now.

As to the Internet, its development has nowadays afforded us easier access to a whole wealth of information throughout the world. According to a survey released by the China National Network Information Center, by the end of last year there were 8.9 million netizens in China, most of whom were people aged between 24 and 35. I'd like to point out that the added value of information is reflected by the fact that it is open to all and shared by all. So I hope all young people, both Chinese and foreign, and all scientists and scholars around the world will make the best use of the Internet and other means of communication.

Science: *Are you satisfied with current efforts by the Chinese Academy of Sciences and the government to lure back Chinese scientists working abroad? If not, what more can the government do?*

Jiang: Generally speaking, I'm satisfied. But a great deal of work remains to be done. Competition in scientific research is competition for talent. Many developing countries, China included, have seen brain drain to varying degrees. Since 1978, about 110,000 of the 320,000 Chinese who have gone abroad to study have come back and made contributions to the country. Of course, for various reasons, quite a number of them have decided not to—at least for the moment—come back, which is understandable. The Chinese government is taking measures to attract them back, including introducing more favorable policies and more flexible mechanisms and creating better working and living conditions for them. Meanwhile, all sorts of technology- or business-development parks set up by local governments at all levels have served as incubators for scientific and technological development and for turning research results into products. I believe more and more people will come back as our economy develops and research conditions improve.

"The Chinese government encourages collaborations between Chinese scientists and their foreign counterparts. What it discourages is nothing more than the collection of [genetic] samples by individuals or companies for commercial purposes in the name of scientific research."

Educational reform and science literacy

Science: *Can China become a world leader in research if its education system continues to school young people in the accumulation of facts and the copying of wise people of earlier eras? If not, what must be done to encourage creativity and innovation?*

Jiang: I myself grew up under China's traditional education system. We must see the two sides of our traditional system. There are many good things in our traditional system. The basic education in China has produced a great number of world-renowned scientists and engineers who have made important contributions to world civilization and progress. I think schooling young people in the accumulation of facts should be encouraged. Of course, it is even more important to encourage creativity based on predecessors' achievements. We are reforming the educational system by promoting all-round development, combining education with scientific research, and cultivating creative and innovative people. I have full confidence in the ongoing educational reform.

Science: *How concerned are you about the level of scientific literacy among China's citizens? What initiatives, if any, do you support to improve science education in grade school?*

Jiang: Fundamentally, future competition hinges on talent, or on the overall quality of the people. To improve our people's overall quality and cultivate talent is a long-term systems engineering challenge. As a Chinese saying goes, it takes a decade to grow a tree and a century to cultivate people. I think China, as a developing country, should keep improving the scientific literacy of all its citizens. On the one hand, efforts should be redoubled to publicize popular science, encourage people to learn science, love science, carry forward the spirit of scientific research and innovation, and advocate scientific methods. On the other, the 9-year compulsory education system should be promoted in a comprehensive manner. Reform of curricula should be deepened and efforts should be made to set up extracurricular activity bases and science museums to enhance students' creative capabilities and promote all-around development.

The dark side of science and technology

Science: *As was mentioned earlier, scientific breakthroughs often bring their own concerns. In the West, many people worry about genetically modified foods, stem cell research and cloning, genetic testing, the potential for telecommunications and nanotechnology advances to erode an individual's right to privacy, and so forth. What is your view?*

Jiang: We are also very much concerned about these. The prevention of gene-based discrimination, the protection of privacy, the right to information and justice—these are all issues of concern to us. I think it is important to uphold the principle of freedom of science. But advances in science must serve, not harm, humankind. The Chinese government is now mulling over new rules and regulations to guide, promote, regulate, and guarantee a healthy development of science. I believe biotechnology—especially gene research—will bring good to humanity. And I also believe that telecommunications and nanotechnology advances will have profound, positive impacts on the future of our society.

However, in my conversations with President Clinton and with your former presidents Carter and Bush, I shared my concerns with them: How can we protect our young people from the negative impact of the Internet? The media have been developing very rapidly. And I have been telling people in the media often quite candidly that we are open to opinions and suggestions from people from all walks of life, but one thing must be ensured: that facts should not be distorted. And I think this should also apply to the Internet. Otherwise people will wonder how to tell truth from distortion on the Internet.

Science: *Some in China feel that one of the negatives from the West is the threat they see coming from foreign companies to China's intellectual property, including its genetic resources. Are you concerned about this and, if so, what is China doing to combat that threat?*

Jiang: Intellectual property is a very important issue. I have always stressed that we should respect the intellectual property rights of others and know how to protect our own. I believe a "win-win" outcome can be achieved by collaborating with the West according to the principles of equality, mutual respect, and mutual benefit. As far as genetic resources are concerned, China issued in June 1998 the Provisional Rules on the Management of Human Genetic Resources, designed to promote international cooperation and exchanges under these principles [*Science*, 18 September 1998, p. 1779]. The Chinese government encourages collaborations between Chinese scientists and their foreign counterparts in the field. What it discourages is nothing more than the collection of samples by individuals or companies for commercial purposes in the name of scientific research. Since the provisional rules took effect, collaborations between Chinese research institutions and Harvard University, NIH [the U.S. National Institutes of Health], and some European research institutions have been going on smoothly.

Jiang's world view

Science: *Finally, Mr. President, you have studied the West carefully, analyzing strong and weak points. Perhaps you could share some of your views.*

Jiang: Yes, I have made in-depth comparative studies of the United States and European countries. The U.S. is a rather young country with a relatively short history, whereas Europe has a much longer history. So what is the reason for the very rapid development of the U.S.?

You know that as members of the Chinese Communist Party, we highly respect Marx and Engels. I have read some archive materials and learned that Engels visited the U.S. from August to September of 1888. He realized that the U.S. was a rather open-minded and creative country. Therefore, many talents from all over the world have migrated to the United States, and people in the States are always ready to learn anything good from other peoples. As a result, the U.S. is able to learn and take advantage of all the strong points of people throughout the world.

Some people believe that Europeans tend to love traditional things more. Hoping to see a united Europe, European countries have introduced the euro and have expected their euro to counter the U.S. dollar to some extent. But the euro is today faced with the devaluation problem. Last year, I visited Switzerland, Italy, Austria, France, and many other European countries. And this question has always been on my mind. Europe has a long history. In spite of the bourgeois revolution in Britain some 300 years ago and the French revolution over 200 years ago, there has still been a legacy of feudalism in Europe in different forms.

So with my background in science and technology, I have come to this conclusion: The world we live in today is a colorful and diverse one. One should not possibly expect to have one single universally applicable political model. In university days, we had tests with alternate current generators. We used different methods to do the tests, and yet we all got similar results. I have often cited this example to frankly illustrate this point of mine in my discussions and exchanges of views with leaders of many countries.

One thing that I am rather envious of is that Clinton, Chirac, Blair, and Schroeder are all of a younger age. They are very capable and also eloquent. Each leader has a different domain. For me, science and technology is my field, while President Clinton is a legal expert. Therefore, discussions and exchanges of views between leaders will afford leaders opportunities to learn from each other's strong points and to make up for each other's deficiencies. For this reason, I am a strong advocate of personal contacts between leaders of different countries. Of course, we may also exchange information through telephones and the Internet.

"We are open to opinions and suggestions from people from all walks of life, but one thing must be ensured: that facts should not be distorted. And I think this should also apply to the Internet."

English, too. With a translator seated just behind him, Jiang delights in sprinkling his observations with occasional sentences in English.

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