CHINESE ACADEMY OF SCIENCES

CAS President Engineers Major Reform of Institutes

Lu Yongxiang's job is to prod the crown jewel of Chinese science into embracing the type of research needed to sustain economic growth

BEIJING—One month after the People's Republic of China celebrated its 50th birthday with a vast military parade, the Chinese Academy of Sciences (CAS) took a very different approach to mark its golden anniversary: a symposium at which half a dozen Nobelists pondered the challenges facing science in the next millennium. The idea came from CAS President Lu Yongxiang, who oversees the country's premier network of research laboratories. And the look ahead was particularly appropriate as Lu leads CAS through the most ambitious reorganization in its history.

The three-stage, 12-year reform effort will consolidate more than 120 institutes into 80 or fewer, and cut in half a payroll of 50,000 permanent positions (*Science*, 8 January, p. 150). "There was quite a bit of redundancy," Lu says about the structure that grew up over half a century. His aim is a leaner, more flexible, and more productive network of institutes, with greater support for those whose ideas survive competitive review.

An engineer trained at Aachen University in Germany, the 57-year-old Lu is the youngest president in the academy's history, and his reforms have produced a cadre of institute directors in their early 40s. His own field is fluid mechanics, but he gets high marks from CAS scientists for taking a broad view of science. Yang Huanming, director of the Human Genome Center of the Institute of Genetics in Beijing, says Lu was quick to grasp the importance of linking China's fledgling human genome efforts to the international Human Genome Project, for example. "Without his support, [China's participation] would not have been supported by other governmental departments," Yang says.

Mild-mannered and soft-spoken, Lu is a good listener. But he's not afraid to act in the cause of reform. He's eager to implement new guidelines from the Ministry of Science and Technology that give scientists a big slice of any revenue from commercializing technology developed in their labs as an incentive to focus on applied as well as basic research. He also has control over a $2.5 million director's fund to support high-risk but high-payoff projects that have not received sufficient funding through the usual channels.

Although it will take years to judge the results of the current reforms, researchers say they like what they have seen so far. "This [reform] movement will really create a better research environment," says Yuan Yaxiang, director of the Academy of Mathematical Sciences in Beijing, which was created by consolidating four previously separate math institutes. Lu says modestly that it hasn't been hard to win support for his ideas. "Everyone realizes the need for reform, and even the older scientists have come around," he says.

Impatient reformer. Lu wants Chinese scientists to break away from the pack and become more independent thinkers.

Lu laid out his vision for CAS in a 2-hour interview with *Science*'s Tokyo correspondent, Dennis Normile, and Li Hui, a correspondent for *China Features*, at the conclusion of the anniversary symposium, held here from 1 to 3 November. Here are excerpts from that conversation:

On the need for reform: "The basic concept is to find a way to promote research that suits the needs of science and also reflects Chinese characteristics. We need to get rid of redundancies and correct problems that have resulted from cultural practices and the implementation of a planned economy. Science advances very quickly, but our scientists and our scientific organizations did not keep pace with scientific developments.

In the past, few institute directors did a good job of encouraging the mobility of scientific talent. Once people got into the system, they just worked and waited for retirement. And once a group formed and a research topic was finalized, it would just go on. There was no flexibility, there was no adjustment to reflect scientific or technological developments. This is not good for science and technology."

On its implementation: "The reform will be done in three phases. The first phase lasts 3 years, and about one-third of the [previously 123 CAS] institutes are being consolidated into 12 research centers as a pilot program. The second phase, from 2001 to 2005, will see another 30 to 40 institutes restructured into about 18 centers. The last phase, from 2006 to 2010, will be to consolidate the reforms and restructure the remaining institutes.

The [additional] money is not a lot by international standards. We give our institutes [the equivalent of $20,000 to $25,000] per person per year. But even so, it is better than before, and I believe that the government will continue its support [for restructured institutes] at the same level."

On staffing: "The goal is to optimize the personnel structure. At the same time that we are reducing permanent staff, we are increasing the number of doctoral students, postdocs, and visiting scholars. Right now we have 11,000 graduate students. In 3 to 5 years, we will increase this to 25,000. Right now we have 1000 postdocs; we hope to increase that number to 2000 to 3000. We are not only a research organization, we're also a training organization. We have also started a visiting scholar project, to invite up to 300 senior scholars annually, both from within China and from overseas, to join CAS institutes temporarily."

On peer review: "We have introduced peer review, using not only domestic experts but also international experts. We need to provide consistent support for free, fundamental research. However, we just cannot support everything suggested by scientists. We have to be selective. For basic scientific research, we need to rely on international peer review or evaluations to guarantee that the quality of the science is up to international standards.

For long-term projects to develop technologies critical to the nation's economic and social development [products that China badly needs but cannot easily obtain from the industrial world, such as microelectronics and supercomputers], we have to take a strategic approach. And here we feel we don't have to resort to the international community. Chinese scientists know better what

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their country needs for development, and we can maintain high standards even using purely domestic peer review."

On CAS's mission: "In terms of our research and development mission, CAS's role is different from the universities, different from private enterprises, even different from the National Science Foundation of China. [Not only do] we have to do better basic science, we also have to explore the areas of technology that will be critical for the nation in the future.

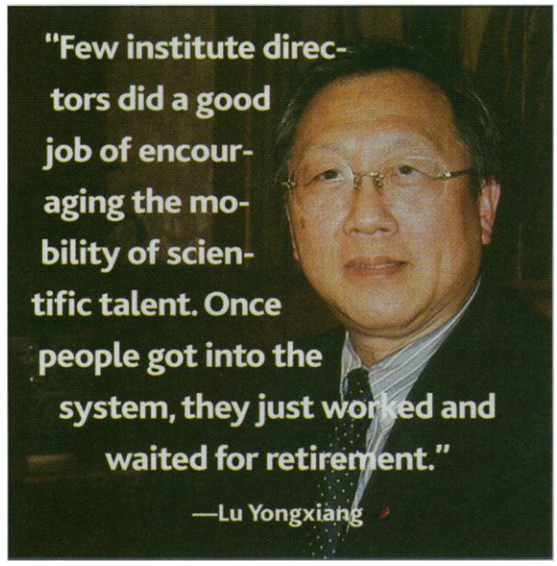
For example, we think we should contribute to promoting the health of the Chinese people. But this should be focused on understanding basic phenomena related to health. This will involve an understanding of gene functions and the basic functioning of the neurological system to provide the scientific basis for the treatment of human disease."

On commercializing results: "In the past, if a project had commercial potential we'd keep it to ourselves. Now we want to get other people involved in the development. A second point is that previously any innovation or patent [from publicly funded research] belonged to the government and the institutes. The innovator was not allowed to profit from it. Now we think it is more important to respect human resourcefulness. [A 1996 law] allows the researcher to take the lion's share of any profits.

We also want to develop multiple channels for development. We will collaborate in various ways not only with state-owned enterprises but also privately owned enterprises and foreign companies. For instance, if a research result appears to have potential for commercialization, the entire research team could join a commercial enterprise, or they could cooperate with a private entity, or form their own independent company."

On setting priorities for basic research: "We do not plan to repeat what is being done in other countries. But we have our unique attributes. For instance, we have unique genetic resources—both fauna and flora. And we have the well-established traditional Chinese medicine. After the human genome is sequenced, the emphasis will be on functional genomics, which will play an important role in drug development. In addition to genomic drug development, we should be able to produce drugs based on the long history of the use of traditional herbs. We will use modern methods to refine the active compounds and produce new pharmaceuticals."

On cross-disciplinary research: "In the first half of this century, science tended to become more narrowly focused. For instance, there was particle physics, and then condensed matter physics. And even condensed matter physics was further divided into semiconductor physics [and other subdisciplines]. This limited the generalization of science and also cross-disciplinary cooperation. But the modern approach to science is to emphasize integration and synthesization. Particularly over the past 50 years, the most outstanding scientific accomplishments have occurred at the intersections of various disciplines.



Lots of people say that it is very important to emphasize cross-disciplinary cooperation, but once they get money they are very reluctant to carry it out. Cross-disciplinary cooperation is not an easy thing to do, but we have to try our best."

On funding risky research: "In basic scientific research, particularly in emerging areas, which are the most risky areas, we're giving institutes more autonomy in terms of how they use their resources. We're also giving project leaders more autonomy in deciding how to spend project funds. CAS headquarters cannot dictate what to do, but we will review progress.

But CAS headquarters does have a role to play in the most risky areas. There may be proposals that institutes think are too risky and are very unwilling to support. The scientists can come to headquarters for help. The president has a special budget for more risky projects. They can get support to start the project, and, depending on results, the president will continue the support or decrease the funding."

On winning political support: "The 1997 Asian financial crisis really woke us up. The government started to discuss with scientists and with other leaders what economic development really depends on. The conclusion was that it depends on scientific innovation. The globalization of the economy also demands that we improve our innovation skills and ability.

After the Asian financial crisis, we produced a report on knowledge innovation and economic development. That report was sent to all high governmental leaders and all members of the National People's Congress. And we plan to produce three more reports, one on sustainable development, one on advanced technology development, and one on scientific development. We don't ask for money. There are no specific projects or ideas. We just give the background on the necessity of scientific development. After the first report, I received personal letters from Premier Li Peng and other political leaders. They were very appreciative."

On the pace of reform: "On one hand, I'm satisfied with what we've achieved. On the other, I'm dissatisfied and hope for more. Part of the satisfaction is that the support for reform from both the government and the research institutes has been greater than anticipated. But there is still room for improvement in terms of the research direction and implementation, and the improvement of mechanisms and structure.

Chinese culture has a lot of strong points, but some elements are very conservative. People are not ready to do anything that is totally different from what others do. There is a certain lack of independence in fields like science. Researchers tend to follow research trends.

Personally I'm interested in the different innovative experiments of Germany, the United States, and Japan. In the first half of this century, Germany achieved a great deal by gradually accumulating talent and strategic knowledge. The United States has done very well, particularly in the second half of this century, by being very innovative in entrepreneurial terms. America has attracted talent from all over the world, in part because of the [flexibility of] American culture. Japan, of course, has taken a different approach, being very successful in industrial technology innovation. By learning from the experiences and lessons of other nations, China will have to find its own way forward."

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