

## Cultural reflections

**China's economy is booming and yet its scientific output isn't. Mu-ming Poo explains why.**

**T**o great acclaim, Wang Ying-lai and his team at the Institute of Biochemistry in Shanghai announced, in 1965, that they had synthesized biologically active insulin. Similar research was being conducted in labs in the United States and across Europe, but Wang's discovery was well in advance of his rivals, and ushered in a new era of synthetic proteins. This example, unfortunately, is the exception rather than the rule for Chinese science. China has a long way to go to be recognized as a leading scientific country, but rapid progress is being made.

Modern scientific research did not begin in China until the early twentieth century. The founding of the Academia Sinica and its associated research institutes in 1928 signified its beginning, but its activity was seriously disrupted by intermittent wars and political turmoil. Science has had little chance to take hold.

Now, given the soundness of the Chinese economy, the steady increase in the government's funding for basic and applied research, and the general appreciation of the importance of scientific development, the time has come for China to make its presence felt on the international research stage.

I have helped to build several academic programmes in China during the past two decades, and I now believe that the remaining obstacles to Chinese research institutions achieving excellence are cultural rather than economic.

### Authority versus creativity

The Confucian tradition of respecting customs and hierarchy has cast a long shadow over modern China. Authoritarian rule and political conformity in the past decades have hampered the creation of an

environment that fosters individual creativity. Deference to authority and to existing paradigms is a major barrier to scientific breakthrough.

Science education in China is extensive and rigorous, and has won universal praise. But it takes more than this to cultivate scientists; students should be inspired to pursue knowledge itself, and a habit of raising questions needs to be fostered. Challenges to existing evidence, hypotheses and concepts, however naive, ought to be encouraged and seriously addressed.

Respect for authorities and the spirit of conformity leave their mark on the style of scientific research as well. Research programmes in China often closely follow existing lines of research in the West, using similar paradigms. This often leads to competition at a disadvantage.

Colleagues in China often complain that their results are not appreciated, whereas similar work performed in Western countries is published in high-profile journals.

Strengthening the uniqueness of their work will increase its visibility, as will improving its presentation. At the Institute of Neuroscience in Shanghai, we give regular scientific-writing classes, using drafts of manuscripts to illustrate how to improve clarity and precision.

These skills are important, but ultimately it is confidence and skill in attacking important problems at the forefront of science that will lead to major discoveries and international recognition.

Critical scientific exchange is rarely seen in China, especially in public. Yet open and frank dialogue is urgently needed to make scientific conferences in China not just friendly gatherings but intellectual events that stimulate ideas. Undue courtesy may be indispensable for maintaining the Confucian order in a traditional Chinese family, but it is detrimental to research institutions. One way to overcome this might be for the organizers of scientific meetings to begin with the statement that critical or negative comments are to be taken as constructive inputs.

The attitude towards critique is also relevant to the submission of scientific papers to international journals. Critical comments by referees may at first glance seem unfair or

hostile. Researchers would benefit from a more positive approach: it is often useful to reflect upon the comments and then go back to the laboratory bench, rather than sending the paper immediately to a different journal without much improvement. For example, investigators from the Institute of Neuroscience have made great efforts to improve the quality of the work upon rejection of their papers, and this approach has been rewarded by a marked increase in the number of publications in high-quality journals in the past few years.

### Essential tension

A lack of well-trained researchers is another drawback in most Chinese institutions. Since the late 1970s, hundreds of thousands of students and researchers have gone abroad for advanced training. A fraction of these people have now returned to China, and they constitute a major driving force in Chinese science. It would be of interest to compare the productivity of these researchers before and after their return. For those who did not perform as well in China, we need to look at why. Is it because of insufficient research funding or the lack of a stimulating environment?

In major research institutions around the world, there is always an 'essential tension' that drives scientists to put their heart and mind into solving scientific problems. This atmosphere is created by a desire to excel, by challenges from surrounding colleagues and students, by competition with scientific peers or simply by the pressure from the 'publish or perish' culture.

An intellectual environment where 'adversity breeds creativity' is critical for scientific discovery and technological innovation. Chinese students and researchers working overseas have earned universal praise for their intelligence and diligence, but it is the competitive environment in which they work that has shaped them into high achievers. I expect that when such an environment is provided in China, important scientific achievements will emerge. Thus the most urgent task in building research institutions in China is the creation of an intellectual atmosphere that is conducive to creative work. Until a large number of returnees can accomplish inter-

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**Submission to rules and rituals is the foundation of Confucian education, yet deference to authority and existing theories is a major barrier to scientific breakthrough.**

simply because of poor research performance — a common practice in major research institutions elsewhere. Traditionally the Chinese government has taken care of the entire life of a scientist, from college graduation to retirement, regardless of their performance. The result has been the absence of pressure and a lack of incentive to excel.

Many research centres are now instituting regular reviews of their scientific staff. However, a successful merit-based review system requires objective evaluation of research performance and achievement. This must include the reviewers remaining anonymous — an unfamiliar concept to the Chinese. In China, this process is hampered by the shortage of qualified reviewers in each scientific area. Extensive use of international colleagues, as practised by all major research institutions around the world, will help to solve this problem.

**Distinctive goals**

The rapid scientific progress in the West poses a formidable challenge to Chinese research institutes. We need to ask whether there are sufficient resolve and resources to compete with Western institutes on major unsolved scientific problems.

Despite the spectacular success of the genome projects, major breakthroughs have mostly originated in small laboratories pursuing their own research interests. The important remaining scientific problems are generally well recognized, yet effective approaches to them remain elusive. Opportunities abound for distinct scientific explorations.

It will take time to develop distinct approaches to science away from mainstream influences, and it requires patience and persistence on the part of individual scientists and scientific administrators.

After decades studying Chinese science and civilization, Joseph Needham<sup>1</sup>, a historian of Chinese science, concluded that it was the Chinese form of ‘bureaucratic feudalism’ that inhibited the rise of modern science. A major challenge for China in the new century is to overcome the past and begin a fully fledged development of its research institutions. ■

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1. Needham, *J. Sci. & Soc.* 28, 235 (1964).

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**Burdens beyond science**

As well as providing a conducive intellectual environment, Chinese institutes have two other important tasks: reform of the administrative structure, and establishment of a merit-based system for staff evaluation and resource allocation.

Complaints about administrative constraints are universal, but there is an added hurdle for Chinese scientists. Scientific research, like many other aspects of Chinese society, is under direct government control. Major funding is usually awarded to organized research projects that involve large numbers of investigators and subjects that are clearly defined by the government.

Scientific administrators at all levels have enormous responsibility — and power. These administrators often control resources and give instructions rather than

provide services. Substantial restructuring of the administrative system, including reducing the number and increasing the efficiency of administrative staff, as well as simplifying budgeting and reporting procedures (while retaining reasonable fiscal accountability), will be important.

**I am not aware of any research institution in China that has terminated the contract of a scientist simply because of poor research performance.**

The recent restructuring at the Shanghai Institutes for Biological Sciences is an interesting example. Here supporting offices of several institutes are integrated into central units, with increased efficiency and reduced staff numbers. If steps can be taken to prevent researchers from feeling alienated from central-office staff and homogeneous office practices overriding unique institute needs, this approach may prove a good model for groups of institutes in related research areas.

The quality of a research institution depends on merit-based appointment, promotion and resource allocation. I am not aware of any research institution in China that has terminated the contract of a scientist