



Q&A Anthony Cheetham

China still rising

Materials scientist Anthony Cheetham, vice-president of Britain's Royal Society, outlines how China's approach to recruiting and funding scientists is driving steep increases in Chinese research productivity.

What are your experiences of working with researchers in China?

I have been to China about 15 times in various capacities. As a science adviser to the board of Unilever from 2000 to 2008, I visited the company's lab in Shanghai at least once a year. From 2004, I ran the International Centre for Materials Research at the University of California, Santa Barbara; it was clear that science was really taking off in China, so building links there was one of my top priorities. I went on to co-chair the first US–China workshop on advanced materials, for which we took a delegation of faculty members, students and post-docs to Beijing. After I moved to Cambridge in the United Kingdom, we continued the link with a UK–China workshop over here.

In which types of institution does the best scientific research take place?

Much of the leading science is done in the institutes of the Chinese Academy of Sciences (CAS), which subsumes two different roles. It has academician roles, like those at the Royal Society or other science academies, but it also runs roughly 100 institutes covering all facets of science and engineering. These are distributed around the country with something of a concentration in Beijing and Shanghai. It is a little bit like the German system in which a lot of the outstanding research takes place in Max Planck institutes rather than in universities. Although most of the best science happens at CAS, China's top universities are also very impressive.

In which fields is the country strongest?

Overall, the number of Chinese publications in leading journals is roughly comparable to that of the United Kingdom, France, Germany or Japan. What was striking was that when I looked at the trend from 2000 to 2014, although there were variations from year to year, there was steep upward growth in all areas for China.

Among the major science categories, Chinese growth was steepest in chemistry, to the point where the country is now second in the world in terms of overall output behind the United States. In physics, China is comparable with the United Kingdom, perhaps slightly overtaking us, yet in life sciences it still lags behind — although again the gap is narrowing.



JON ENOCH

My interpretation is that China has invested heavily in science across the board, but it is easier to make rapid progress in a discipline like chemistry because you do not need the large, sophisticated infrastructure that you often do in physics. And, on the other hand, funding for the life sciences is particularly strong in Britain.

Is the funding application system fair and effective?

In 2010, I went to China as part of the first international evaluation of the National Natural Science Foundation of China (NSFC), which is their equivalent of the US National Science Foundation and of bodies like the UK Engineering and Physical Sciences Research Council (EPSRC). I was impressed by the quality of the NSFC's processes when it came to funding grants. We were a small committee of half a dozen international scientists and two or three Chinese scientists, and we were given unfettered access to anybody we wanted to speak to and given a large amount of data about trends in applications, about their volumes and pass rates. We were able to interview stakeholders in the whole process, including not only people from the NSFC, CAS and China's Ministry of Science and Technology,

but also administrators and grant holders from universities. We found that the NSFC commands a huge amount of respect among Chinese scientists.

Funding that goes through CAS is done differently, but nevertheless Bai Chunli, its president, is looking at ways to improve the evaluation of the performance of its institutes and individuals within them. CAS feels it has to work a bit harder to justify its large tranche of funding from the public purse. It has been seeking international advice on this, and the Royal Society sent a delegation over there a couple of years ago as part of that process.

What specifically does the NSFC do best?

It is doing peer review very well. The programme officers we met were outstandingly good. There was a lot of transparency in the system so that even when people did not get funding, they felt they had been given a fair opportunity. They are also very proactive on scientific misconduct and have an established system for monitoring it and prosecuting cases. To be honest, if we had done the same in-depth evaluation of a funding body like the EPSRC, I suspect that the council would have come out of it with a similar or maybe even lower score than the NSFC.

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Do Chinese scientists face particular pressures relating to how their work is disseminated?

Salaries and funding decisions are directly related to numbers of publications in high-profile journals. This emphasis on quantitative metrics also applies to the evaluation of candidates for academic positions. I know from supervising Chinese postdocs that if they want to go back to China, they need a minimum of four or five publications in a well-defined list of high-quality journals, and that they must be either the first or a corresponding author.

It is a competitive system and the quality of science coming out of China is getting better each year. I personally would like to see them placing greater emphasis on evaluating people and reading what a researcher has done, rather than ticking boxes and using the impact factors of journals as a surrogate for quality. I suspect that the number of people applying for positions is huge. If you are deluged with candidates, that might explain some of the rather crude tools used to filter them.

Critics suggest that this focus on metrics encourages a culture of seeking quick, short-term wins. Do they have a point?

There are different ways of responding to the pressures in the Chinese system. Certain things can't be done quickly. There are people

everywhere who are interested in short-term success and I don't think the Chinese are any different in that respect.

I do think that the emphasis on publications in high-impact journals can drive some bad behaviour. There is concern that in a minority of cases it can encourage falsification of data and plagiarism. These things happen everywhere but are perhaps more likely when rewards are tightly linked to outputs.

Compared to other countries, China spends proportionally less money on basic science and more on developing existing technologies. Does this make the country less likely to make fundamental discoveries?

Based on the sheer volume of work its scientists publish in world-leading journals, it is ill-informed to think that China is not very good at discovery. These are not journals that publish derivative stuff. There may be more money going into developmental science, but the amount in absolute terms going into discovery science is probably higher than in most Western countries apart from the United States. The processes they have in place clearly enable them to support an ever-growing amount of high-quality science.

How good are Chinese scientists at translating their scientific discoveries into applications that benefit society?

China has a long way to go when it comes to capitalizing on its scientific base. The concept of gaining real economic advantages from its investment in science is more embryonic there than elsewhere. In the United Kingdom we have the Catapult innovation centres to help to do that, and other countries across Europe have similar institutions. Whether it is training in entrepreneurship for scientists or helping them to start companies, these things are not as well developed in China. Venture capital exists but it is nothing like the level in Britain, let alone the United States. The Chinese recognize that their capability in science has outstripped their ability to take advantage of it, and they need to build up their capabilities.

What could outsiders learn from the way Chinese researchers manage their science?

We could learn a lot just by observing the speed with which they have gone from being minor league players 20 years ago to being in the very front ranks of international science today. It's a phenomenal success story. Beyond the substantial and sustained financial investment, what I can say from my experiences of taking Western students to workshops in Beijing is that they are generally amazed by the levels of enthusiasm of their Chinese counterparts. There is no doubt that young scientists in China have incredible levels of passion and drive that we don't often see in the West.

INTERVIEW BY NIC FLEMING