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GUEST EDITORIAL

The other side is greener, or is it?

Oxford University Chancellor Patten is disturbed by the rising number of Indian students heading to US universities. He has sought the help of leading Indian companies – Reliance Industries, Tata Consultancy Services and Infosys Technologies – to set up an India research centre at the Said business school at a cost of \$17 million to reflect India's rising global importance, says a report datelined 10 March 2006. 'We are losing some of the best (Indian) students to the US, and since our reputation depends on being seen to trawl the world to attract the best, that has got to be a worry', he said. Currently there are only 200 Indian students studying at Oxford compared to 540 from China.

Martin C. Jischke, President of Purdue University and a member of the Council of Advisors on Science and Technology to President Bush, is worried that the international demand to study in American universities is on the decline. He wrote in the *Southbend Tribune* of 7 March 2006, 'I believe we are experiencing a global sea change that threatens not only our universities but also America's security and its economy'.

While Patten thinks that the US is grabbing Indian students expected to go to Oxford, Jischke thinks that overseas students are no longer coming to the United States in large numbers. He is clearly worried that highly talented foreign students, both Indians and others, may be 'sensing that the advantages of studying on American campuses no longer are great enough to justify overcoming the obstacles to entering this country'. How difficult it is to enter USA has been a topic of discussion in the Indian media ever since two of our leading scientists were denied permission to enter early this year.

There has been a race between Europe and the USA for supremacy in science. American scientists again won a majority of the Nobel Prizes last year. It was the sixth consecutive year that Americans led the number of laureates. Since the first Nobel Prizes were awarded in 1901, 290 of the 684 winners (up to 2005) in all six categories – or 42.4% – have been Americans. Many of the other winners have also carried out the prize-winning work at US universities. Just two Europeans were recognized in 2004 and three in 2005. Europeans are trying hard to close the trans-Atlantic gap in scientific research. Analysts attribute

US supremacy not only to American know-how, but also to American funding that supports thousands of scientists across the country. Europe is trying to level the playing field, but that could take decades. The United States has a head start and spends more than twice as much annually on scientific research than all European Union nations combined (\$271.2 billion vs \$123.3 billion).

But both the Americans and the Europeans are worried about China and India as emerging competitors.

Although Europe is home to CERN, the European Organization for Nuclear Research, the world's largest atom-smashing laboratory which helped to stem brain drain from postwar Europe to the United States, 'In terms of Nobel prizes, publications, patents and science students, Europe is losing ground at an alarming rate', lamented Jacques Chirac, the French President, on the occasion of the laboratory celebrating fifty years of service. More significantly, he said that the competition 'no longer comes from the major powers in the developed world, such as the United States or Japan. Each passing day sees more competition from the large emerging countries, like India and China'. The European Union is also trying to offset a huge 'brain drain', with tens of thousands of European scientists and specialists moving to American universities, institutions and companies every year, by trying to attract more researchers from Asia and developing nations.

In the US, scientists, politicians and business leaders are concerned that their country could fall behind in the global 'brain race' and is about to be deposed as the world's leader in science and technology. A few weeks ago Bush proposed in his State of the Union address a \$136 billion boost in science education and research over the next 10 years. 'We cannot afford to be complacent. In a dynamic world economy, we are seeing new competitors, like China and India', he said. What is more, he came to India to open a new chapter in Indo-US relations.

While the 20th century had the arms race, the competition in this century will be a brains race, says science policy analyst Michael Lubell of the American Physical Society. 'Today's *Sputnik*? It's a little bigger. It's called China'.

Twenty years ago the United States, Japan and China each graduated a similar number of engineers, with South

Korea graduating about half as many. By 2000, Japan has increased its output by 42% to 103,200, South Korea has recorded an 140% increase to 57,650 engineers, according to Jischke. In contrast, the number of US engineering graduates had declined by 20% to less than 60,000. In 2004, China graduated 500,000 engineers, India, 200,000, and North America, 70,000, says a National Academy of Sciences report. If this trend persists, then by 2010 more than 90% of all scientists and engineers will live in Asia, fears Jischke. Besides, one US chemist's or engineer's salary is enough to hire five Chinese chemists or 11 Indian engineers.

While Americans still file and obtain large numbers of patents, their per cent share is falling as others, especially Asians, have become more active and in some fields have seized the innovation lead. The United States' share of its own industrial patents has fallen steadily over the decades and now stands at 52%. A more concrete decline can be seen in published research. American papers in *Physical Review*, in the past two decades, fell dramatically. In 2004 the total was just 29%, down from 61% in 1983. On the contrary, China, says Martin Blume, the journals' editor, has surged ahead by submitting more than 1,000 papers a year.

'Although the United States continues to possess the world's strongest science and engineering enterprise, its position is jeopardized both by evolving weakness at home and by growing strength abroad', states a recent National Academy of Sciences report.

But should the US and Europe really worry about India and China?

Let us look at some key performance indicators. According to *ISI Essential Science Indicators*, among 149 countries considered, India ranked 21st for papers, 13th in citations and 119th in citations per paper, based on data for the period 1 March 1992 to 31 December 2002. Based on data for the period January 1995 to June 2005, China ranked 14th for papers, 8th for citations and 123rd for citations per paper.

In the five years 2000–2004, India and China had accounted for 2.39% and 4.66% respectively of the papers in science as a whole as indexed in the *Web of Science*. Both India and China had published substantially larger per cent of papers in materials science (4.79% and 11.56%), chemistry (4.23% and 8.29%), and physics (3.45% and 9.15%). India accounts for 5.3% of papers in agricultural sciences, and China has a substantial presence in engineering (6.89%), mathematics (8.95%) and computer science (5.48%). But, in none of the 19 fields into which all papers are classified, the relative impact is even close to one, meaning that papers from these two Asian giants are cited much less often than the world average in every field. In particular, Indian papers in almost all fields of

life sciences are poorly cited: Immunology (32% of world average), molecular biology (32%), biochemistry (37%), plant and animal sciences (30%), and agriculture (35%). China's papers are cited somewhat more often: Immunology (41% of world average), molecular biology (53%), clinical medicine (76%), microbiology (57%), plant and animal sciences (72%), agriculture (83%). Indian work is cited somewhat better in physical sciences: physics (79% of world average), materials science (71%), chemistry (62%), computer science (82%), and engineering (65%). The corresponding figures for China are: physics (64% of world average), materials science (78%), chemistry (64%), engineering (77%), computer science (75%), and mathematics (84%).

During the period January 1995 to August 2005, both China and India were among the 20 most cited countries of the world in chemistry. But their papers were cited an average of 4.35 times for India and 3.58 times for China, compared to 13.4 times for USA, 12.97 times for Switzerland, and 12.76 times for the Netherlands. India and China figured in the twenty most cited countries in physics also. Again their papers were cited on average far fewer times than papers from USA or Europe: 3.34 times for China, 4.63 times for India, 10.91 times for USA and 12.17 for Switzerland. Both India and China did not figure at all in similar 20 most cited countries lists for clinical medicine and molecular biology and genetics.

Make no mistake, India and China have a long way to go before they can really pose a threat to either the USA or Europe in science. We shouldn't be carried away by reports on US science being threatened by Asia's educated elite. What the Americans are threatened about is with regard to jobs and manufacturing, not science. What is possible is that both India and China can grab an increasing share of jobs wherever they are allowed to. As Thomas Friedman wrote in *The World is Flat*, 'China does not just want to get rich. It wants to get powerful. China doesn't want just to learn how to make GM cars. It wants to be GM and put GM out of business'.

Indeed, as a first step both India and China need to improve the quality of education. We should take the statement of N. R. Narayana Murthy of Infosys that almost 75% of our graduates are unemployable seriously.

We may have a billion people, but the number of people who can do science is rather small. As Inder Verma argues, scientific research will not take off unless the country encourages innovation and rewards excellence. I would recommend that we establish dozens of centers of excellence in order to improve innovation and the quality of our scientists, and gear the system of school education to promote innovative thinking.

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