succeed in improving the quality in existing institutions and universities.

It is also incorrect to infer that the global trend is responsible for the present disenchantment with science[1], since our 'golden era' ended long before independence, and in spite of increased opportunities following implementation of the Science Policy Resolution when others continued to excel. The two facts I mention below would perhaps help explain how the decline may have come about and dispel the misconception regarding the role of western culture in Indian science.

Firstly, most of the eminent scientists were taught by European teachers or found their mentors in them. Thus the shine was certainly aided by the western intellectual tradition in the profession which disappeared before we could internalize those values presumably due to hightened reassertion of our cultural unity and heritage to consolidate mass support for political independence. Our oft glorified *chalta hai* culture successfully swept away the scientific ideals from our minds as evident from Haldane's alarm[2] within two decades of our independence.

Secondly, Indian educationists then, to whom we attribute foresight today, thought it necessary to promote the cause of science and liberal education in the western pattern. They did not hesitate extolling the western tradition in the same vein as the west's appreciation of Greek tradition for the emergence of modern science. For instance, Asutosh Mookerjee believed in imbibing the western scholastic traditions without aping them, and brought to limelight personalities like Raman, Radhakrishnan and Ganesh Prasad amongst several others of international eminence. In his address at Mysore, that *visualized India's role in eventual globalization*, he said[3]:

'We cannot sit on the lonely snow-capped peaks on the Himalayas absorbed in contemplation of our glorious past . . . We cannot waste precious time and strength in defence of theories and systems which, however valuable in their own days, have been swept away by the irresistible avalanche of worldwide changes . . . we can live neither in nor by our defeated past and if we would live in the conquering future, we must dedicate our whole strength to shape its course . . . *let us raise an emphatic protest against all suicidal policy of isolation and stagnation*' (emphasis added).

Similarly, the great educationist Gopal Krishna Gokhale, a friend of Asutosh Mookerjee was of the view[4]:

'I think and this is a matter of deepest conviction with me that in the present circumstances of India all western education is valuable and useful. Even if it is not the highest it is not on that account to be rejected . . . in my mind greatest work of western education in the present day is not so much that encouragement of learning as *the liberation of the Indian mind from the thraldom of old world ideas and the assimilation of what is best in the life and thought and character of the west. For this purpose not only the highest but all western education is useful*' (emphasis added).

Therefore, the claim of Virk[1] seems to be at variance with what is clearly on record. It is true that the exposition of Hindu religion and its philosophies by the likes of Swami Vivekananda and Radhakrishnan did bring about a profound change in the perception of oriental culture in the western world, but there is no reason to believe that it influenced the essential tenets of the modern scientific inquiry in any significant manner though, perhaps indirectly it boosted the morale and developed a faith in our abilities in general.

In my view, Ramamurthy's observations and suggestions are more appropriate[5]: '*We need to do science that will create more and better jobs*' (emphasis added). And not the other way round!

1. Virk, H. S., *Curr. Sci.*, 2000, **78**, 659.
2. Haldane, J. B. S., Reproduced in *Curr. Sci.*, 1999, **77**, 305–307.
3. Quoted in Sinha, N. K., *Asutosh Mookerjee: A Biographical Study*, Asutosh Mookerjee Centenary Committee, 1966, p. 146.
4. *ibid*, pp. 112–113.
5. Ramamurthy, V., *Curr. Sci.*, 1999, **77**, 1568.

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A bibliometric analysis of scientific research in India

A number of bibliometric analyses[1–6] have been carried out during the last two decades to evaluate the research productivity of Indian scientists. Most authors have used the CD-ROM version of the Science Citation Index (SCI) to map scientific research in India.

Rashmi Mehrotra and F. W. Lancaster of the University of Illinois, USA, published their findings in *Current Science*[1] during 1984. Their database comprised 38,000 research publications produced in India during 1979 to June 1981 and indexed in SCI. Among the top 25 institutions of higher education and research in India, Indian Institute of Science (IISc), Bangalore occupied the top position followed by Banaras Hindu University (BHU), Varanasi; Delhi University, Delhi; Madras University, Chennai and Calcutta University, Calcutta. Surprisingly, four universities/institutes from Punjab, viz. Punjab Agricultural University (PAU), Ludhiana; Punjab University, Chandigarh; PGIMER, Chandigarh and Guru Nanak Dev University, Amritsar were also included in the top 25 institutions of India. Similarly, Uttar Pradesh (UP) was represented by Aligarh Muslim University, Allahabad University, Roorkee University, Lucknow University, Meerut University and Agra University among the top 25. It was quite revealing that *Current Science* turned out to be the most productive Indian science journal out of a list of 35 journals published in India which were used in the SCI database. Indian scientists published 50% of their papers in Indian journals and 50% in foreign journals with higher impact factors. The percentage of research publications by the university scientists was

higher than that of research institutions funded by CSIR and DAE.

Arunachalam *et al.*[2] based their analysis on more than 42,000 papers published by Indian scientists in 2300 journals indexed in the SCI during 1989–92. This study revealed that Indian contribution to world scientific literature is showing a decline as India came down from the 8th position in 1980 to 12th position during 1989–92. Chemistry and physics account for bulk of research publications from India, followed by engineering and clinical medicine. Again, the most productive Indian journal was *Current Science* followed by *Indian Journal of Chemistry* and *Pramana – Journal of Physics*. This analysis gave a macroscopic view of science in India as reflected by the literature covered by the SCI and did not rate universities/research institutions as reported by Mehrotra and Lancaster[1].

Basu and Nagpaul[5] made a bibliometric assessment of India's scientific publications based on the SCI for 1990 and 1994 in their report, published by NISTADS, New Delhi. This is one of the most comprehensive surveys of Indian scientific research publications and covers 4000 journals including 12 from India indexed in the SCI. The report gives detailed analysis on disciplines, specializations, institutions, states and rankings of 3000 Indian research institutions on a floppy disk. The top 50 institutions are rated on the basis of research output and impact factor. IISc, Bangalore occupies the top position with highest output and high impact. Out of the Indian universities, Aligarh Muslim University occupies the top slot in the category: small output–high impact. It shows the quality of research based on impact factor only. Surprisingly, BARC, Trombay and BHU are listed in the category: high output–low impact, while NPL, New Delhi has a very poor rating in research and is classified in the low output–low impact category along with PAU, Ludhiana, Kurukshetra University and M.D. University, Rohtak. IISc occupies the top position among 25 research institutions of India in most of the field of science and technology. BHU, Delhi University, Hyderabad University, Pune University and IITs find a slot among the top 25. Among the Indian states, Maharashtra produces the highest percentage of research papers followed by West Bengal, UP and Delhi.

Aparna Basu *et al.*[6] published their brief report, which was circulated in January at Pune, the venue of 87th Indian Science Congress. It was based on 5000 + journals covered by the SCI. The conclusions of this survey are contrary to the frequently expressed views[7–9] about the health of Indian science. It claims that there has been no fall in the output of scientific papers published from India annually and indexed in the SCI over the last 10 years, despite the fact that the SCI covered journal use by Indians has fallen from a steady 45–50% to 28% at present. The number of Indian journals covered by the SCI fell from 36 in 1980 to 11 during 1997–98. One may believe the conclusions of this survey with an iota of doubt.

Among the top 20 most productive institutions, IISc, BARC and TIFR, Mumbai occupy the first three positions followed by BHU. There are only 6 universities among the top 20 institutions during 1997–98 compared with 14 in the first survey[1]. It clearly shows a sharp decline of research output in Indian universities during the last two decades. While the research productivity of some national level institutions has remained steady, the universities are losing ground due to poor funding *vis-à-vis* research organizations, e.g. DAE, Space and Defence. None of the universities from Punjab occupies a slot among the top 20 institutions of India.

1. Mehrotra, R. and Lacaster, F. W., *Curr. Sci.*, 1984, **53**, 684–687.
2. Arunachalam, S., Srinivasan, S. and Raman, V., *Curr. Sci.*, 1998, **74**, 433–441.
3. Arunachalam, S. and Manorama, K., *J. Sci. Ind. Res.*, 1992, **51**, 329–340.
4. Garg, K. C. and Dutt, B., *J. Sci. Ind. Res.*, 1992, **51**, 329–340.
5. Basu, A. and Nagpaul, P. S., NISTADS Report No. Rep. 248/98, New Delhi.
6. Aparna Basu *et al.*, NISTADS Report, New Delhi, January 2000.
7. Arunachalam, S., *Curr. Sci.*, 1998, **74**, 397–402.
8. Virk, H. S., *Curr. Sci.*, 1998, **74**, 397.
9. Virk, H. S., *Curr. Sci.*, 1998, **74**, 817–818.

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S&T in India

This is in the context of G. Padmanaban's article on recent trends in S&T in India (*Curr. Sci.*, 2000, **78**, 381–382). I agree wholeheartedly with his observations and would like to add a few comments from the perspective of an IIT.

Prospective employers who frequent the campus here are mainly interested in what software courses the students have taken – not their specializations. So after a few cursory questions on their subject, all engineers from Electrical to Agriculture and Mining find themselves recruited for the same type of desk jobs. Is this what we rationalize as 'Borderless Science and Seamless Technology'? Then who does the actual engineering and production?

For some years we have been noticing the apathy of students to doing experiments involving working with their hands. As one who has worked with hardware all his life, I now find it difficult to attract and enthuse students for growing new materials, studying phenomena and making devices that work. No doubt the work is painstaking and even frustrating at times. But the same students with a PC will toil away all day (and night in air-conditioned rooms) on some simulation which may have little relevance to actual science and technology. And, what is worse, all the software is borrowed.

The IITs face questions regarding the high cost of education provided to students who on completion queue up for US visas. Studies by DST have shown that not more than 25% of students go