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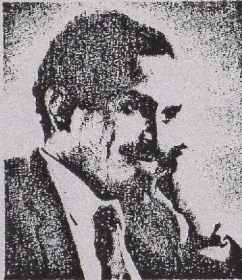
Is there an Indian Science and Technology?

"We still suffer from what Dr Kalam calls the 'fifth country syndrome'"

❑ A View



"Dr Kalam often asks why we take pride in saying that we are the fifth country in the world to achieve something or the other. Why can't we be the first now and then?"

Prof R Narasimha, Director, National Aeronautical Laboratory and Member, TIFAC Council, offers a view on Indian science and technology. This article first appeared in Utsav, *a souvenir published at the University of Cambridge.*

So much has been written about science and technology in India — its successes and failures, its organisation (or lack of it), its budgetary support, and its role in national development — that to say more about it in the same vein seems superfluous. It might, instead, be worthwhile to consider some other issues concerning the subject — a broader, even if subjective, sketch seems preferable. One such issue is the question raised in the title: all of us speak freely of *Indian* art, *Indian* literature, *Indian* music etc. Is there, and should there be, *Indian* science and technology as well?

Some general points need to be made first. Most importantly, it is necessary to recognise that science is *not* new to India. According to Debiprasad Chattopadhyaya, the scientific attitude first becomes evident in India in the ancient literature in medicine. The great Caraka, whose *Samhita* discusses health and disease in rational, cause/effect terms, said *sukham samagram vijnane vimala ca pratishthitam:* "all happines is rooted in good science". Indian contributions to mathematics, in particular to algebra and arithmetic, were fundamental. An Arabic compendium called *Hisab-ul-Hind* ("Indian Calculus") expounding Indian methods of calculation, and other related books, were freely translated and circulated widely in Europe nearly thousand years ago, with the support and collaboration of such well-known names as Fibonacci, and undoubtedly helped lay the foundations of modern mathematics in the West. The renowned mathematician Hermann Weyl acknowledged in 1929 that occidental mathematics has during the last several centuries trodden a path whose origins could be traced to India. Indians were probably the first people to look upon grammar not as an arbitrary set of rules but as science: their success might have killed Sanskrit as a language of common intercourse (and nearly killed many unwilling students in recent decades!), but laid the foundations of a scientific approach whose value is recognised when one attempts to construct artificial languages or to devise schemes for mechanical translation from one language into another. The passion of Indian grammarians for economy of expression is illustrated by that ancient epigram *ardhamatra laghavenapi putrotsavam manyante:* "if half a syllable can be saved they celebrate it like the birth of a son" (feminist objections notwithstanding).

Similarly in astronomy, geometry, chemistry etc. Very fundamental notions, such as whether matter and time are discrete or continuous, were widely discussed. Philosophers like Nagarjuna (7th century AD or earlier) propounded ideas about truth and inference that sound strangely modern.

There is no doubt that till about a thousand years ago there was a well-recognised *Indian* science: indeed Alberuni complained around that time that Indians thought there was no science like theirs — pointing incidentally to a smugness that undoubtedly was in part responsible for the decline that followed, for the achievements of Indian science in the second millennium definitely do not compare with those of the first.

Something similar may have been true in technology as well. Legend has it that one of the prized gifts that Alexander took during his raid was a ball of Indian steel. Indeed metallurgy has been a strong point of Indian technology for a long time through so-called Wootz steel and the Damascus sword to as late as the 18th century when steel was still being exported to Britain. The rockets used by Tipu against the British in the latter half of the 18th century were perhaps the last instance of a technologically superior product made in India.

However, it seems clear that the developments that took place during the scientific and industrial revolutions of the last five centuries or so in the West quickly went far beyond Indian thought or capability of the time. Strangely enough, it looks as if the gap in technology may have been recognised earlier than that in science, if we go by the concern expressed by such pioneers as Raja Rammohan Roy around mid-nineteenth century about the poor state of the "mechanical arts" in India. On the other hand, a remarkable Indian mathematician named Yesudas Ramchundra was attempting, as late as during the turbulent 1850s, to find "Indian" algebraic alternatives to the differential calculus, at least in the special problem of finding extrema of functions, on which he wrote a book which was published in both Delhi and London (the latter with the enthusiastic endorsement of de Morgan). Ramchundra's scientific effort, like the great Indo-British War of 1857, may have been the swan-song of "old" India in its forced encounter with the West.

Another half century was to pass before a new Indian response was institutionally formulated. The Indian Institute of Science was established under Jamsetji Tata's inspiration in 1909, with the firm cultural support of leaders like Swami Vivekananda and against the protests (during the previous decade) of British commercial interests in India. A few years later the Indian Science Congress was started; the Indian Association for the Cultivation of Science provided a

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haven where C V Raman and his colleagues did outstanding work. During the first half of the 20th century the country produced the first Indian geniuses exposed — in fact only rather imperfectly — to Western science: Raman, Ramanujan, Saha, S N Bose and others did creative science in a more or less Western style, but they were all educated in India and rooted in Indian culture — most strikingly so in the case of Ramanujan, whose exposure to western mathematics was as rudimentary as his response was singular, characterising a period in the cultural history of India that has probably passed for ever. It is also the period that produced the haunting picture of C V Raman weeping that he had to wait under a Union Jack when he was in Stockholm to collect his Nobel Prize.

Science and technology grew rapidly in republican India, along lines that had been sketched earlier by people like Visweswaraiya: Pandit Nehru saw them as central to the nation's development, cultural as well as economic, summarising his outlook when he characterised the Bhakra-Nangal dam (I believe it was) as a "modern temple". Looking back on that period, one cannot help being struck by the extraordinary act of faith and strength of vision that led to the bold initiatives of the 1950s: in electronics, aeronautics and nuclear science as much as in agriculture, in the establishment of the Indian Institutes of Technology, and in the rapid growth of various industries such as steel, machine tools and locomotives in the public sector. But the first impressive success of these policies had to wait for the early 1970s, when it began to become clear that the country had broken the back of its age-old food problem. The famines of the colonial and early republican years began at last to look like the unpleasant nightmares of a bygone era. Looking at the statistics, it now seems clear that the new trend in agriculture established itself in much less than a decade after the Bihar famine of 1965–66, when everybody around the world — not only those who produced (and continue to produce) what Mahatma Gandhi accurately characterised as "gutter inspectors's reports", but also the more liberal, intellectual friends of the country — was ready to write off India for ever. The agricultural exercise demonstrated beyond any doubt that if the goals were clear, visible and widely accepted, there was enough skill and talent available in the country — among its scientists, engineers, politicians and bureaucrats, and among the people at large (remember how our farmers used to be called "ignorant" and "superstitious" till the 1970s?— nobody dare use those false adjectives any more) — to tackle even major technological, social and economical challenges. The point has of course since been made in many other fields: atomic energy for example, and space and missile technology in particular. In many of these areas India has joined a

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small club of less than 10 nations around the world with similar capabilities. Dr A P J Abdul Kalam likes to say that we now suffer from the "fifth country syndrome" — i.e. that we take pride in saying we are the fifth country in the world to achieve something or the other, and that the time has come for us to be the first now and then.

One can make a good case for saying that there are three technologies in India. We have already touched on one of them—we can call it the 'state' sector: technology developed (and usually mastered) through major public agencies of one kind or another. At the other end of the spectrum we have what we may call "cottage" technology — small-scale units that turn out some widely needed product, using basically the native ingenuity of the old craftsman tradition: small centrifugal pumps, light diesel engines, the simpler machine tools etc. There is no R&D backing these efforts, no national advertising selling their products. But in their own way they have been very successful, and have in recent years been joined by a new kind of highly skilled entrepreneurs, making special chemicals, machine tools, software and so on. Several Indian cities are now surrounded by small companies ("high-tech cottages", if you will) each with a very few professionals whose confidence, stamina (an essential virtue in our country, by the way) and success are apparent for anybody to see. The growth of this sector can only bring credit to the country, and should in my view be most actively encouraged: it could well hold the key to the future of "Indian" technology, and a symbiotic relation with the state sector could work wonders.

Paradoxically these two sectors account for only a small fraction of the total national product in engineering: the big industry, both private and public, that supplies the needs, especially of urban consumers, has by and large relied on foreign technology. Examples abound: automobiles, electrical machinery, telephones, television etc. etc. In a market which is becoming very large (the middle classes in India already constitute a more numerous group than those in UK, France and Germany combined), the technology is still basically colonial. Explanations for the colonial character are not hard to find; the austerity of the young republic (attempting to discourage what it saw as merely wasteful urban consumption), the ready availability of competing technology from elsewhere, the risks associated with indigenous development, and many other factors related to our economic policies appear to have been the driving forces in this sector. Our weaknesses here, combined with the national penchant for self-deprecation, have given the country an unjustified sense of failure.

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atmosphere, which at one and the same time has been both restrictive and protective. It has been assumed without questioning that India could not be internationally competitive. It is astonishing even now how rarely we know exactly where we stand in the international market place: when forced, it has often been found that we are not at all as badly off as widely feared. The future surely lies in economic policies that are more open — not only to the outside (selectively), but inside as well. The major unsolved problems in our basic infrastructure — transport, energy, housing, communications — need to be seen as extraordinary opportunities in science, technology and economics, rather than as national headaches. But experience elsewhere in the world has taught us that Mahatma Gandhi's prescription is still valid: keep your windows wide open for fresh air from all sides, but make sure you are not blown off your feet. Is it possible that fading respect for this rule is responsible for what some thoughtful observers of the Indian scene have feared is happening: namely that Indian science in the republic is more widespread, competent and professional than ever before, but at the same time less creative? Growing internationalisation seems everyday a surer road to prosperity, but should this not begin by exploiting our natural advantages — which are cultural and human, more than anything else? Science *is* an international enterprise, and we cannot and should not be chauvinistic about it; after all, we have learnt a great deal from the West in the last century. But without our science and technology taking on a distinctively Indian style and character, i.e. without their total assimilation into our culture, can we make many truly significant *international* contributions? The way we adapt ourselves to this new situation in our cultural history during the 1990s will probably determine the long-time health of the nation, and whether we will have an Indian science and technology in the third millennium that will match or surpass the achievements of the first.

A rocketeer in Tipu Sultan's army carrying the kind of rocket used by the Mysoreans in 1792.

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