atlas. Effects of such calamities on various categories of houses (RCC, bamboo- or brick-constructed or mud huts) are expressed in a lucid, but tabulated manner. Establishment of a centralized body like Earthquake Evaluation Research Centre (EERC) by DST is a historical necessity. The Geological Survey of India (GSI), a premier 150-year-old earth science organization had created an Earthquake Division on 15 April 1999 in the National Capital Region, Faridabad, Haryana. Better coordination and understanding with other central organizations was the sole criterion for establishment of such a division. But GSI is bent upon its closure and as a first step, recently shifted it to Lucknow, with only two scientists. The rest of the scientists were posted to other places. Its closure is imminent. It is an unfortunate development and EERC shall oppose such a move. Among 212 seismological observatories in India, 75 are manned by India Meteorological Department (IMD) and only 57 stations are chosen for determination of the epicentres of earthquakes. It appears strange that earthquake data of India are monitored and maintained by the Weather Office, IMD. Further, meteorologists dominate the IMD and seismologists occupy insignificant positions in the department. EERC may be entrusted such a specialized assignment. Majority of 212 observatories may be networked for compilation of earthquake data.

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Bandwagon science in India

P. Balaram's comment in the editorial, 'Lost innocence' (*Curr. Sci.*, 2001, **81**, 229–230), 'There is, presumably, little new physics to be gleaned from nuclear blasts' is not supported by facts. The inadequacy of the current state of knowledge of physics available, which goes into the design of nuclear weapons, may be judged by browsing through the recent issues of *Physics Today* (December 2000) and *Los Alamos Science* (2000, **27**). Nuclear-weapon states would not be spending billions, if Balaram's view was tenable.

I am of the view that Balaram's advice to the academies in India 'to limit their domain to conventional academic science and avoid straying into the difficult waters of strategic science and technology', is already being followed. This is reflected in the elections to the fellowship. A. P. J. Abdul Kalam was not elected by one of the academies. However, (with due respects to her), late Indira Gandhi was. This attitude has also led to the proliferation of 'bandwagon' science in India. The research on high-temperature superconductivity is a prime example. In India, nothing much has emerged from this, both in the academic and the technological areas. On the other hand, it has encouraged the import of scientific instruments and killed whatever little efforts on building indigenous instrumentation existed in the country.

It may also be difficult to compartmentalize science into two neat categories of academic and strategic science. A few examples will suffice to illustrate this. The tetraflop computers, like Blue Pacific developed for 3D simulation of nuclear weapons, are also being employed to understand protein folding. In the middle of the 20th Century, a storehouse of data on nuclear and radiation transport cross-sections was developed essentially for design of weapons and nuclear reactors. Who would have imagined then that in the future this database combined with Monte Carlo statistical methods will be used for creating a new tool for analysing and planning radiation treatment of cancers?

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The mill tailings of Kolar gold mines

B. R. Krishna and F. H. Gejji (*Curr. Sci.*, 2001, **80**, 1475–1476) have highlighted the environmental pollution being caused by the dumping of the mill tailing (sand) in the Kolar gold mines area. It is true that there are about 32 million tonnes of this sand, which makes up the 15 dumps spread out along 8-km long distance in the mine area. These sands have been causing considerable environmental health hazards to the people of the Kolar gold field. During the months of June/July when the weather is dry and windy, these sands are carried eastward to Robertsonpet and Andersonpet areas, over a distance of 3 km. The finer particles get air-borne and finally settle down up to a radial distance of 4 km. With the onset of monsoon, the rainwater carries these sands further down onto tank beds. These sands are essentially made up of grains of quartz and amphibole minerals, with a fineness varying the < 100–< 200 mesh size in the proportion 30 : 70, respectively. The major constituents of these sands are given in Table 1.

The authors' apprehension that these sands cause health hazards like silicosis, lung cancer, etc. is not based on facts. According to Gowda and Shenoi[1] of M/s Bharat Gold Mines Medical Department, 'although the gold mines are 100 years old, so far there is no reported occurrence of silicosis in any of the employees of the Kolar gold mines. They further confirm that silicosis, as seen in the famous Rand gold mines of South Africa, does not exist in the Kolar gold field. However, a form of pneumoconiosis (lung disease) is commonly found in underground mine workers and their most recent study (1973–1978) on 5893 workers has shown a decline in the prevalence rate of pneumoconiosis. The mill tailings have so far not caused any respiratory health hazards or skin diseases or allergies to the people of Kolar gold field area. At best, these sands can be considered as a nuisance and should be ignored as innocuous.

Table 1. Major constituents of sand in the Kolar gold mines area

Constituent	Percentage: Light-coloured	Dark-coloured
Calcium oxide	8.4	7.6
Silica	56.0	51.8
Aluminium oxide	11.9	8.2
Ferrous oxide	10.2	18.9
Magnesium oxide	8.6	6.3
Loss of ignition	2.0	3.9

As for the possible industrial use of these mill tailings, so far all attempts made in the past have proved to be either futile or uneconomical. In the early fifties, the British engineers mixed these tailing sands with Portland cement and after reinforcing with steel rods, manufactured fence-posts pillars, slabs, etc. Since these products lacked the required strength, they all cracked up and broke. In another attempt, during the 1980s the Bharat Gold Mines Ltd (BGML) supported a S&T project by the Cement Research Institute of India (CRII) for manufacture or Portland/Pozzoland cement by blending these tailings with high-grade limestone obtained from Bagalkot in Belgaum district. Although technically it was found feasible, the final assessment was that economically it was not viable for two reasons: (1) For each tonne of mill tailings, four tonnes of high grade limestone had to be procured from Bagalkot area and transported over 400 km distance. (2) All the major constituents like SiO_2, Al_2O_3, MgO and Fe_2O_3 were almost double in percentage compared to specifications.

Krishna and Gejji's contention that about 20–22 million tonnes of these tailings has been lost due to denudation is not correct. The total quantity of tailings generated during the last 120 years is about 35 million tonnes and the present (1999) estimate is 32 million tonnes. The difference of 4 million tonnes is accounted for as follows: (i) Tailings used for filling voids underground for sand stowing: during 1956–1980, 1.6 million tonnes[2]; during 1980–2000, 1.4 million tonnes (BGML source); total, 3.0 million tonnes. (ii) The balance 1 million tonne may be accounted for denudation.

During 1981–1989 about 2,03,500 tonnes of tailing sand found around Walker's shaft in the Nundydroog area was treated and 106 tonnes of scheelite (tungsten ore) was recovered as a by-product by BGML. The mill tailing sands contain about 0.75 g of gold/tonne of sand. So during 1986–1998, BGML treated 3.8 lakh tonnes of sand and recovered 328 kg of gold by heap leaching technology. This involved transportation of sand for 3 km distance to an uninhabitated area which in turn created air pollution enroute. This apart, the cost of other inputs like labour, power, cement, cyanide, transport, etc. was prohibitively high and hence in January 2000 BGML closed down this plant also, as part of its final winding-up operations.

Until 1956, all the underground workings where the gold ore has been extracted, were being supported by timber of granite, which was very expensive. After studying some of the Australian gold mines, BGML also started making use of these sands with water to fill up the stoped-out areas. From 1956 to 2000, BGML used about 3 million tonnes of sand for supporting the underground workings. Perhaps, this is the best use the mill tailings have been put to so far.

The suggestion of Krishna and Gejji of making use of these sands for the manufacturing of hollow bricks, solid columns, reinforced slabs, an additive for Portland cement, for manufacture of stoneware pipes, bottles and bangles, etc. may not be feasible as these tailing sands do not possess the required physical and chemical attributes as specified for the respective industries.

According to Ganapathi Prabhu[3], BGML under technical guidance, undertook an afforestation programme on the tailing dumps, to contain the dispersal of these sands. Hybrid eucalyptus saplings were successfully grown after spreading red-earth and green manure as foundation on the dumps. With good care, the saplings grew into adult trees. The greenery was evident and prevented the sand from denudation. Since January 2000, the maintenance of these plantations has been given up by BGML, as it has wound up all its operations. Now it is left to the Karnataka Forest Department to look after these plantations, to mitigate the environ-