Training science and technology manpower: Fifty years of DAE training school

B. A. Dasannacharya

Some men of vision and action

The generation of a large enough pool of scientific and technological manpower to satisfy the needs of the country has been a subject of thought and action for a century. A number of eminent persons thought deeply about it and initiated action in the beginning of the last century.

M. M. Malaviya and the Banaras Hindu University

When Banaras Hindu University (BHU) was started at Varanasi in 1916 by M. M. Malaviya, the following 'objective' was embedded in its Act:

'To promote learning and research generally in Arts and Science in all branches' and 'To advance and diffuse such scientific, technical and professional knowledge combined with necessary practical training, as is best calculated to help in promoting indigenous industries and in development of material resources of the country.'

BHU has been quite successful in its objectives; graduates from BHU have manned various national science and technology (S&T) institutions and played leadership roles in both private and public sector industrial and research units. By the time of independence, BHU had almost 50 different departments, including forward-looking ones like mining, metallurgy, pharmacy, fuel technology and ceramics alongside sciences, arts, engineering, Sanskrit, Indology, music, etc.

J. N. Tata and the Indian Institute of Science

Earlier, J. N. Tata had initiated action towards establishing the Indian Institute of Science (IISc) at Bangalore. Tata's emphasis was more on industrially oriented subjects. Not surprisingly chemistry and electrical engineering were the first few departments to be started. How this was initially not supported by the then Viceroy and later came to be approved after Tata's death is a fascinating story in itself and has been well-recorded by H. M. Lala in his book *Beyond the last Blue Mountain*. IISc has grown into a premier research institute in the last hundred years.

Mahendra Lal Sircar and the Indian Association for Cultivation of Science

Bengal was in ferment during this time throwing up great intellectuals, men of revolutionary ideas and bold action. (Vidyasagar, Ram Mohan Roy, Tagore and others.) Mahendra Lal Sircar started the Indian Association for Cultivation of Science (IACS) at Calcutta because, as he put it, 'for want of such (trained) men here the Government has to bring out men from England whenever any necessity arises for carrying on investigations in any subject, and even for professorship in its educational institutions … our association will be able to furnish such men'. The brightest star of this institution was, of course, C. V. Raman. If it were not for IACS, Raman would have presumably retired as the highest paid revenue official of the Government of His Majesty in India! Raman himself was a staunch believer in high-class teaching and training. He produced many first-rate scientists, including K. S. Krishnan, S. Bhagavantam and several others. However, for various reasons, he was disillusioned towards the later part of his life and in one of his low moments, bemoaned that, 'my life has been an utter failure. I thought I would try to build true science in this Country. But all we have is a legion of camp followers of the West', something to think about.

H. J. Bhabha and the Tata Institute of Fundamental Research

This brings us to another visionary and the period is some years before independence. Homi Jehangir Bhabha, a brilliant polymath (artist, mechanical engineer, theoretical physicist), returned to India from Cambridge just before World War II. He probably would have gone back to Cambridge, but war conditions did not permit this. He joined IISc and initiated work on studies of Cosmic Rays. As he continued his work, Bhabha became more and more convinced of the need for first-rate institutions for S&T in India. In his now well-known letter to Dorab Tata Trust, justifying the need for such a laboratory he wrote,

'In the last two years I have come more and more to the view that provided proper *appreciation and financial support* (italics mine) are forthcoming, it is one's duty to stay in one's own country and build up schools comparable with those that other countries are fortunate in possessing.' He continued, 'Moreover, when nuclear energy has been successfully applied for power productions, in say a couple of decades from now, *India will not have to look abroad for its experts but will find them ready at hand* (italics mine).'

Consequent upon this the Tata Institute of Fundamental Research (TIFR) was started in the forties in Bombay.

Independence, Nehru and Bhabha

Jawaharlal Nehru saw a vision for Indian S&T, similar to that of his predecessors and after independence, scientists like Homi Bhabha and Shanti Swarup Bhatnagar were given special mandates towards development of S&T. Bhabha had already clear ideas about the development of nuclear science and atomic energy, as mentioned earlier. There was a viewpoint then that as this field was in the forefront of S&T and India was too backward and poor, it should not venture into the development of nuclear energy. A number of Western and Indian scientists held this view. However, Bhabha's perspective was broader and he had a long-term vision. He realized that full development of this area of science and this form of energy provided an opportunity for Indians to make progress on an extremely broad front, which included practically all areas of basic S&T.

To get our perspective right let us consider the breadth of S&T required. At the core of development of nuclear energy, one needs to design and build a research reactor. One needs to create a design team of reactor physicists and engineers for this. Such a concept of putting basic scientists and technologists together to achieve a defined purpose was certainly new for those times in India, but quite natural in the way of thinking of Bhabha. He aimed to achieve this in his scheme of things. A reactor requires input of various materials like uranium, special alloys, heavy water, etc. in a highly pure form in a specified metallurgical state and this requires metallurgists. The control of reactor and safety monitoring needs radiation detector systems and electronics. Processing of used uranium fuels again requires knowledge of chemistry, chemical engineering and development of remote handling techniques. Utilization of the atomic reactor for the production of medical and industrial isotopes and making radiopharmaceuticals needs its own kind of expertise involving materials scientists, life scientists and others. Use of thermal and fast neutrons for fundamental research in nuclear physics, radiation chemistry and condensed matter physics requires trained basic scientists. Bhabha, the engineer-turned-physicist saw clearly that for a balanced and true development of any technology basic sciences must play a central role, since real breakthroughs invariably occur when the science involved is understood at a fundamental level; so basic research has to have an important role in the total process of training for development. The first atomic reactor, *Apsara*, built by India and which became operational in 1956, had inputs from basic scientists and engineers from different backgrounds. In short, knowledge of all areas of S&T is needed for a broad-based growth of atomic/nuclear industry.

DAE training school (for total nuclear development)

Soon after this landmark achievement, Bhabha started an activity which has proved to be the most important foundational activity of the Department of Atomic Energy (DAE) and to an extent of the S&T activity of the country itself. This was the DAE Training School, which was started in 1957 and has now completed 50 years. The task of implementing this scheme was given to Raja Ramanna, then a young man of thirty-two and who later became the Chairman of DAE.

The first batch of graduates recruited for this consisted of about 150 physicists, chemists and engineers. Recruitment was done through a rigorous and purely scientific/technical interview, with a view to selecting a group of young people who should be trained for creativity than in copying and duplicating existing design alone. Persons selected for training went through a course work over a period of one year and had to clear tests in each subject at the end of course work prescribed. The subjects within each discipline included basic to fairly advanced ones and were often taught by persons involved in allied research activity to the extent possible. A broad spectrum of subjects was included. For example, physics students, apart from conventional physics subjects, were given courses on reactor physics, health physics and nuclear engineering. Similarly, for other disciplines also. I was a student of physics in the first batch and so can say with confidence that the quality spectrum of our teachers was quite broad. Some were simply brilliant (Singwi, Udgaonkar, Aneesur Rahman, K. K. Gupta, to name a few) and have made a permanent place in the minds of their students. Senior-most scientists (who were still quite young then: Raja Ramanna and M. G. K. Menon included) to some young ones were involved in lecturing and tutoring. This process of course work and test ensured that occasional misjudgements in selection interview, which is bound to happen in any selection process, got corrected through the evaluation process. As the selection interviews were rigorous, success rate at the end of the course was quite high, typically above 90%. At the end of the year, the successful trainees were all employed in various units of DAE, including TIFR and the Atomic Energy Establishment, Trombay (AEET; now Bhabha Atomic Research Centre (BARC), Mumbai). Those marginally below par were offered lower grades and were at the liberty to continue or leave.

It was felt that bright undergraduate and postgraduate students in physics and chemistry could be recruited and trained together. At the end of the first year of the training programme, this decision was seen to be justified as undergraduate students competed favourably with the postgraduates. This pattern continued for over a decade and a half, after which undergraduate students were not recruited for a variety of reasons.

Over the years, a number of additional features have been added: laboratory work and visits to various research laboratories were included and an end-of-the-year viva voce became part of the curriculum. Tutorials were considered essential from the very beginning.

This mode of recruitment with training has proved to be sound and has continued for the last 50 years; the consequence has been heartening indeed. The Training School which was conducted by BARC (then AEET) with the help of scientists from TIFR and initially, for a year, with IISc (in power engineering) has continued with its essentials remaining the same. A number of methodological changes (like a pre-test before the interview, use of computer-based question bank for pre-test, etc.) have been introduced and refinements put in place. By now more than 7500 persons have graduated from the Training School and have been offered employment. India's space programme was taking-off in the late 1950s and a number of successful trainees were offered positions there. More such training programmes have been started within the DAE at Mumbai, Kalpakkam, Indore, Hyderabad, etc. to fulfil its mandates. They include orientation training for post M Tech recruits, specialized training in reactors, heavy water, applied physics, radiological physics, life sciences, etc.

Fifty years

At the end of 50 years, it is legitimate to ask if the programme started in 1957 has been serving its mandated purpose. In my opinion, this has been one of the most successful personnel training programmes in the country. Bhabha's vision that, 'India will not have to look abroad for its experts but will find them ready at hand', has been completely realized. Today, India is fully competent in all aspects regarding the needs of nuclear science, technology and their applications, largely due to those trained under this scheme.

Raja Ramanna, in one of his talks at the International Atomic Energy Agency, Vienna in the sixties, emphasized that if one wishes to retain five good personnel at the end of twenty-five years, one has to start by training fifty. Many more than this have stayed with the atomic energy programme and those who have left have contributed to various scientific activities in India. Alumni of the Training School have gone on to shoulder the highest responsibilities in various units of the DAE, like BARC; Nuclear Power Corporation of India Ltd, Mumbai; Nuclear Fuel Corporation, Hyderabad; Electronic Corporation of India Ltd, Hyderabad; Heavy Water Board, Mumbai; Board of Research in Isotope Technology, Mumbai; Indira Gandhi Centre for Atomic Research (IGCAR), Kalpakkam; Raja Ramanna Centre of Advanced Technology (RRCAT), Indore, etc. They have also held the highest positions in other outside units like Department of Space, Bangalore; Defence Research and Development Organization, New Delhi, and Department of Science and Technology, New Delhi. In addition, basic sciences centres like TIFR; UGC–DAE Centre for Scientific Research, Indore; Institute of Physics, Bhubaneshwar; Institute of Mathematical Sciences, Chennai, etc. have had their Directors from among its alumni. A number of them have been elected to fellowships of various prestigious Indian and foreign Academies and Associations of S&T. However, the real sign of its success lies in the fact that the entire burden of the atomic energy programme, both civil and strategic, is borne today predominantly by graduates of the Training School: this is the highest compliment that one can give to this effort started fifty years ago.

Epilogue

It may be asked whether this model is the right one in today's context. It is some times said that this mode of recruitment leads to inbreeding. To an extent, this is true. In recent years parallel recruitment has been done partly to balance this and partly in recognition of the fact that an enormous amount of expertise is also available outside. A measure of balance between the two types of recruitment without any compromise on quality has to be achieved. This is the real challenge.

One of the reasons for starting this scheme lay in the fact that in newly resurgent India (about 1955), while students were hopeful of making good national contributions on the one hand, they lacked confidence to do 'new' things, on the other (because of feudal upbringing in the Indian system). Bhabha and his team took several steps to raise the level of confidence of their personnel by giving them responsibilities. Various denial regimes only added to the need to innovate and try new approaches and ideas. Going into such examples in detail will take me away from the main text of this little story. A few examples, however, are not out of place. Apart from designing and building nuclear reactors, they include large-scale fabrication of nuclear fuels, manufacture of pure and special materials, heavy-water production, remotely handled plutonium production, development of robotic devices, technologies for accelerators, lasers, nuclear explosive devices, isotope-enrichment technologies, development of several varieties of pulses, peanuts, etc. and their transfer into fields, food and industrial products' irradiation plants, production of radioactive sources and compounds for industry and medicine, detectors and electronics for sophisticated nuclear experiments, reactor control electronics, production of strategic materials and computing devices denied to the country, etc. The list is long indeed. It is not the intent of this write-up to suggest that it has been a success story right through. Rather it is to point out that, while we fell many a times, we always stood up and succeeded many more times. The DAE through its training school (now called BARC Training School) has succeeded in creating a cadre of men who are competent and confident of starting any science-based activity from scratch and bringing it to a successful conclusion.

Today the training programme has expanded and what started as a Training School has grown into a Human Resource Division of BARC and Homi Bhabha National Institute (HBNI), which can award postgraduate degrees, mainly M Tech and Ph D. Does this show a reverse trend where a large national institution finds the need to start its own university? Traditionally (in India) a university is involved in teaching and in carrying out research. Publishing research papers is most often an end in itself and peer reviews concentrate on the number of papers published. Major projects are never undertaken within a university. As a result, there is no effort towards innovating or developing new facilities. The DAE has specialized in innovation and development, which have been its strong point. Bright scientists have had to forgo academic acclaim as they spent their efforts on such developments. Will HBNI succeed in giving a different balance and meaning to university research? On the other hand, the role of basic sciences in laboratories like BARC, IGCAR and RRCAT of the DAE has diminished somewhat over the years. With the formation of HBNI, can one expect basic sciences to again get greater recognition and a more respectful place in overall scheme of things? Only time will tell.

B. A. Dasannacharya lives at No. 4, Beach Resort CHS, Plot 1, Sector 10-A, Vashi, Navi Mumbai 400 703, India.
e-mail: dasannacharya@mtnl.net.in