Homi Jehangir Bhabha

B. A. Dasannacharya

A hundred years ago a genius was born amongst us, in a highly cultivated and accomplished family. Nobel laureate C. V. Raman called him Leonardo da Vinci of our times. Another Nobelian Isidor Issac Rabi (discoverer of nuclear magnetic resonance, the heart of MRI machines) said of him: '... perhaps never again will there be a man of such broad culture, such broad vision who was able to understand and live in the most profound depths of Western culture and at the same time be a product of India so that in his own person, we had a man who spanned the whole range of Asian and Western Culture'. Homi Jehangir Bhabha was one in whom West and East dissolved into a single Centre. He was a brilliant intellectual, practical visionary, a passionate missionary and a nationalist in the mould of Sankara and Vivekananda but in the field of science and technology.

Early life

Bhabha was born in Bombay on 30 October 1909, and was educated at Cathedral and John Connon Schools, the Elphinstone College and the (Royal) Institute of Science in Bombay. During this period he was already initiated into Western music and art. At the age of 17 he joined Caius College, Cambridge. His father intended him to become a graduate engineer from Cambridge and join the Tata Iron and Steel Company at Jamshedpur. It was clear to young Homi that he was being trained for a top position at TISCO. However, at Cambridge, which had the world's best theoretical physicists of the time (~1930), he discovered his true passion and love and wrote to his father, 'I seriously say to you that business or job as an engineer is not the thing for me... Physics is my line. I know I shall do great things here .... I am burning with a desire to do Physics. I will and MUST do it sometime.... My success will be what I make of my work. Besides, India is not a land where science cannot be carried on'.

The passion, the willingness to sacrifice, the supreme confidence in his own ability and faith in following the destiny in his motherland and all this at an age of twenty is simply mind boggling.

His father agreed to accept his plea subject to his getting a first class in his mechanical engineering tripos (degree). Bhabha was then allowed to do a second tripos, this time in mathematics, for doing theoretical physics. The next nine years were devoted to theoretical physics research in Cambridge, at the cutting edge of world-class physics of that period.

Science at Cambridge

Study of extra-terrestrial (cosmic) radiations discovered in 1912 by Hess was a subject of intense investigation then. Bhabha published his first paper in 1933 on absorption of and consequent production of a shower of charged particles in cosmic rays, and followed this (in 1937 with Heitler) with a detailed theoretical formulation which was used to compare with experiments and conclusively solve the problem of the 'soft' component of cosmic rays. During this period he gave a quantitative account of scattering of positrons (electrons of positive charge) by electrons: this is well known as 'Bhabha scattering' and even now is used to calibrate positron beams at large accelerators. In an effort to explain the more penetrating 'hard' component of the cosmic rays he predicted the existence of a new particle and showed that 'the majority of the penetrating particles must have masses nearer to a hundred times the electron mass...'. Bhabha pointed out the particle hypothesized by him (meson) should be unstable and decay into an electron (positron) plus a neutrino and that the lifetime of this decay process is given by special theory of relativity: all this was soon confirmed experimentally. The years between 1930 and 1938 established him as a leading international scientist.

Return to India

At this point of time destiny intervened. Bhabha came home in 1939 and due to World War II could not go back. He joined the Indian Institute of Science at Bangalore. The next five years (1940–45) were important in bringing out the nationalist in him even as he started his cosmic rays research group in Bangalore and continued to make important theoretical as well as experimental contributions in the fields of cosmic rays and theory of mesons. Of his work during the war period Lord Penny, erstwhile member for scientific research of the UK Atomic Energy Authority has this to say: 'in this phase of his work he displayed knowledge of and skill in methods of modern algebra to a degree quite unusual among theoretical physicists. He also proved in this work that he could see further ahead than most of his contemporaries...'. He was elected a Fellow of the Royal Society in 1941 at the age of 31.

Tata Institute of Fundamental Research

The extent of activity in physics at Bangalore was simply not adequate for a person of Bhabha's passion and capability. He acutely felt the need for a world-class institution in India to do fundamental physics at the highest level. He therefore set out to achieve this objective by proposing to Sir Dorab Tata Trust 'to build up in the course of time a school of physics comparable with the best anywhere'. With his ability to 'see further ahead than most of his contemporaries', Bhabha ventured to mention in his proposal that 'when nuclear energy has been successfully applied for power production 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'. This was more than a year before the first atomic explosion over Hiroshima. Tata Institute of Fundamental Research (TIFR) thus came into being on Wednesday, 19 December 1945 in Bombay. In his inaugural address as Director, TIFR, Bhabha explained the need for doing fundamental physics at length – 'study of nature for itself unhampered by any preconceived practical ends' – and at the same time emphasized that 'the pursuit of science and its practical applications are no longer subsidiary social activities today'.

In due course of time TIFR became a premier institute from where frontline research was generated. Today, more than 60 years later, it stands as a memorial to Bhabha's first step in building science and scientists within India. Bhabha continued to publish original research papers from TIFR for almost a decade. However, this was also the decade (1945–54) during which his burning passion for 'discovering new secrets of nature' was transformed and subsumed into a new larger passion of seeing India as a front-ranking nation based on science and technology. He had said in his inaugural address of TIFR that 'ideas are some of the most important things in life, and men are prepared to suffer and die for them'. While this might have been said in the context of fundamental physics and mathematics, it is true that development of science and technology in India through the development of atomic energy was an idea for which he would dedicate his life. Towards the end of 1945, under Bhabha's advocacy, an Atomic Energy Committee was established under the aegis of the Council of Scientific and Industrial Research, with him as the Chairman.

Atomic energy

The sky opened on India's destiny on 15 August 1947. A pole star guiding the nation was shining bright and in conjunction was another, whose brilliance would be seen in full glory in the years to come. Jawaharlal Nehru, an ardent believer and supporter of science and technology and Homi Jehangir Bhabha, the visionary, understood each other perfectly and this opened up the grand path for atomic energy. Following the groundwork by this committee the Atomic Energy Act was passed on 15 of April 1948, and the Atomic Energy Commission (AEC) of India was established in August 1948, with a view to surveying essential atomic minerals, developing them industrially, doing research in scientific and technical problems connected with the release of atomic energy, training scientific and technical personnel for this work and fostering fundamental research in nuclear sciences in its own laboratories and in the universities and research laboratories in India.

India's first atomic reactor, Apsara, a 1 MW swimming-pool reactor, operated for the first time on 4 August 1956. This was the first atomic reactor in Asia, outside the Soviet Union. Even before this, in 1955, in his Presidential address at a major International Conference on Peaceful Uses of Atomic Energy in Geneva, Bhabha gave a broad sweep description of forthcoming energy needs of the world and cogently argued that 'atomic energy is not merely an aid, it is an absolute necessity'. He had a vision for India to have a comprehensive programme of developing atomic energy in all its facets from beginning to end. Towards this goal he initiated concurrent activities, starting from mining for uranium, to extraction of uranium and other special materials for atomic energy, to developing electronics for reactor control, to detailed reactor physics, design and construction and reprocessing of used fuel. Health and safety issues and biological effects, including treatment of cancer, were also given due weightage. At the 1955 Geneva meeting, Bhabha also initiated collaboration with Canada for building a 40 MW reactor at Trombay. The uranium metal plant was commissioned in the late fifties and uranium fuel rods for the 40 MW Canada India Reactor, CIR (now CIRUS), was made at the new fuel-fabrication facility, all indigenously. Fuel fabrication, electronics manufacturing, heavy water production and uranium mining were later expanded and spun-off as Nuclear Fuel Complex, Electronics Corporation of India, Uranium Corporation of India and Heavy Water Board.

At the second Geneva conference in 1958, Bhabha laid down the long-term science and technology development route for India's atomic energy programme. This came to be known as the three-stage development programme or the Bhabha plan. At the core of this strategy lies the concept that a large country of the size and population of India should be independent for its energy needs as much as it should be in respect of food and water. Stage I of the atomic power programme starts with somewhat scarce (in India) natural uranium and heavy water-based reactors, climbs in stage II to so-called fast breeder reactors using plutonium obtained from stage-I reactors, and finally, in stage III, ends with reactors using uranium-233 fuel, produced during stage II, from plentifully available thorium from beach sands of Kerala.

While CIR was under construction, Bhabha assigned Indian technologists to design and build a plant for separating plutonium from used uranium fuel rods of CIR. This technology, in view of its relevance to an atomic bomb project, was a secret and the entire job of starting from basics of science to solving the problems of handling highly radioactive substances safely had to be learnt without much help from outside. With the enormous level of confidence which Bhabha would impart to his team, this was accomplished in good time. Bhabha had this quality of being able to attract capable and motivated persons and make them aware of their full potential – sign of a true leader – so that nothing remained insurmountable. Commissioning of the plutonium plant in 1961 at Trombay was the first step for stage II. Incidentally, it also meant that India could now build an atomic weapon if it decided to. Indeed, he mentioned that it can be done in about eighteen months.

During this time Bhabha also initiated steps to induct atomic power into the Indian electrical grid. Tarapur, 100 km north of Bombay, was chosen to install the first power reactor and by 1962, order was placed with an American company. This would familiarize Indian engineers with the technology of nuclear power, enabling a self-reliant growth. A collaboration with Canada was crystallized by 1964 for building a type of reactor which would become stage I of the long-term plan. The scientific-cum-technological base was well laid for a take-off. Steps were concurrently taken to enter into the field of fast breeder reactor which would form stage II of the programme.

Manpower generation

A programme of this magnitude would require building a large number of trained scientific and technological personnel who are capable, motivated and confident of achieving what they set out to do. He therefore started recruiting graduates from universities and training them with a view to having personnel who would not only be first rate in their respective areas of specialization, but also be free from mental shackles inherited because of cultural and historical reasons. In his own words 'The emphasis has been throughout, on developing know-how

indigenously and on growing people able to tackle the tasks which lie ahead. The generation of self confidence and ability to engineer and execute industrial projects without foreign technical assistance have been major objectives'. The effort started by Bhabha in 1957 has resulted in generating more than seven thousand qualified Indians who not only man and lead all the programmes of the Department of Atomic Energy (DAE) today, but have contributed significantly to several other major scientific and technological efforts outside the ambit of atomic energy. The promise that Bhabha had made to Sir Dorab Tata Trust, '... when nuclear energy has been successfully applied for power production... India will not have to look abroad for its experts...', has been amply fulfilled. India is a leading country in the science and technology of atomic energy today and it is these persons who have made it so.

Back to basics

Bhabha sacrificed his personal research in fundamental physics in greater national interest. However, he emphasized that the role of fundamental research is irreplaceable in developing technology. He wrote: '...if much of the applied research done in India today is disappointing or of inferior quality it is entirely due to the absence of sufficient number of outstanding pure research workers...'. Therefore, in addition to starting TIFR for fundamental work in physics and mathematics, Bhabha supported fundamental research within other laboratories of the DAE and in universities in an extensive and substantive way. Work on astrophysics, molecular biology, space science (which was later spun-off as a separate entity of the Government) and nuclear physics within and outside laboratories of the DAE bear testimony to this.

No single Indian has contributed so much to the science, to the development of science and technology in India and to the creation of highly qualified manpower base for the same. Bhabha was a true ratna of Bharat.

Bhabha – the artist

Bhabha was highly accomplished in art and sensitive to finer aspects of life, including music, architecture, etc. His charcoal sketches were published in *MARG* magazine in the late sixties. After returning from a concert late in the night, Bhabha was so moved that he felt compelled to write to his brother past midnight from Cambridge to say that 'in all Beethoven's works... one feels his immense genius, his colossal feeling and the perfection of his music. The Ninth Symphony is sheer greatness, the sublimest and most colossal achievement of human mind'. And about Shakespeare's Antony and Cleopatra, 'He made me weep with intensity of consciousness he has given me'. Bhabha was keenly aware of the philosophical implications of physics and the need to understand this connection which goes beyond the realm of common sense, on a sound scientific basis.

The end

Bhabha died in an air crash over the Alps on 24 January 1966, before he could accomplish his vision in totality. In a short period of about two decades, he established the complete foundation of frontline technology of atomic energy, on which both civil and military programmes of India rest, essentially unchanged even today. On his demise Lord Radcliffe-Maud wrote: 'Affectionate and sensitive, elegant and humorous, dynamic – and now dead. Homi was one of the very few people I have ever known (Maynard Keynes was another) who enhance life whatever the context of their living. In Homi's case this was because he was fantastically talented but so fastidious about standards that he was never a dilettante. Whatever he set himself to do, he did as a professional but one who worked for love. He was restlessly creative, enhancing life because he loved all forms of it. So he became a living proof that scientific excellence can go with excellence in art, racial differences need be no bar to friendship. When Indian Art was last exhibited in London, the one picture chosen for reproduction on the poster outside Burlington House was one of Homi's'. And later JRD Tata said of him: 'Homi was one of those who made me believe that some men in human history are born with a stamp of predestination on them which leads them to accomplishments beyond ordinary human capabilities. Some of them – and Homi, alas, was one – are predestined to die young, an unconscious premonition, which drives them to super human effort to complete their task in the short time allowed to them... Scientist, engineer, master builder and administrator, steeped in humanities, in art and music, Homi was truly a complete man'.

Bhabha has literally impacted India with atomic institutions and power stations spread throughout the country and this has been recognized internationally in many ways, including by naming a lunar impact crater as 'Bhabha' crater.

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