

LESSONS FROM DR. K.S. KRISHNAN - HOW TO FOSTER A CLOSER INTERACTION BETWEEN RESEARCH INSTITUTIONS AND UNIVERSITIES IN INDIA

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1. The brilliant contributions to science and education by the late Dr. K.S. Krishnan at Calcutta, Dacca, Allahabad and the National Physical Laboratory (NPL) have been summarized by various speakers today. Undoubtedly, the name of Dr. Krishnan will be counted amongst 6 or 8 most distinguished and out-standing scientists of this century. Dr. Krishnan was not only a great theoretician but also a highly skilled experimentalist. During his early years of research career in the 1920s, he made pioneering contributions to the studies of molecular scattering of light and x-rays in close collaboration with Dr. C.V. Raman. He was the co-author of the famous paper describing a new type of scattering radiation which resulted in the award of the Noble prize to Dr. C.V. Raman. Over a period of 6 years during 1925 to 1931, he wrote over 30 papers describing these pioneering results. Subsequently, he changed his attention to the studies of magnetic properties of materials at Calcutta and Dacca and earned an international repute for excellence. During his stay at Dacca he influenced many students. During 1942-47 he was Professor of Physics at the University of Allahabad and influenced a large number of students due to his brilliant teaching. In 1947 he became the founder Director of the National Physical Laboratory. He closely guided the development of several divisions of the National Physical Laboratory. He was heavily submerged in various administration responsibilities. In spite of this, he carried out research at the frontiers with the S.C. Jain and S.K. Roy and R. Sundaram. After his departure, Allahabad university declined rapidly.
2. I first came in contact with Dr. Krishnan when he gave a fascinating lecture with practical demonstration of discharge tubes to the 11th Std. students at the Ewing

Christian college at Allahabad. Next year he gave a demonstration on x-rays. He taught me the subject of Electricity and Magnetism in the B.Sc first year, but the Allahabad University lost him soon after.

3. After my M.Sc exam at the Allahabad university in 1950, I met Dr. Krishnan at NPL with a request to work under him. He immediately pulled out a paper from proceedings of the Royal Society on Paramagnetic Resonance by Bleaney & Bleaney and asked me to set up a microwave set up at 3 cm using World War-II surplus equipment which NPL had acquired. I did it within two years but could not get hold of a suitable electromagnet for carrying out research on paramagnetic resonance. NPL did not pay me a single rupee for the first year of my stay at NPL due to the ban on recruitment, as a result of the resource constraints partly due to the Korean war. In 1951 Dr. Krishnan appointed me as Secretary of the Radio Research Committee of CSIR. Thus, I came in contact with Dr. M.N. Saha and Dr. S.K. Mitra and got interested in the field of radio science. In 1953 Dr. Krishnan got me a scholarship to work at the CSIRO, Sydney where they had made outstanding discoveries in the field of radio astronomy. I returned to NPL in 1955 but the NPL could not find 700 Pounds to cover the cost of 32 dishes of 1.8 m diameter which Australia had agreed to gift to NPL. In 1956 I proceeded to USA and returned in 1963 to set up experimental faculty in radio astronomy at TIFR. I had returned to India mainly because I had been deeply influenced by the teaching, guidance and motivation given to me by Dr. Krishnan. I continue to follow the path that he had shown to me.

4. Dr. Krishnan had influenced a great number of research workers in India. He also made numerous contributions to NPL. However, his vision could not materialize adequately because of manpower constraints. In retrospective, it would have been great if the scientific divisions of the NPL were set up within the campus of the Allahabad university and only the applied and industrial part at Delhi, with a sister relationship between the two.

5. Over the last 50 years, India has certainly made great progress in many fields of science and technology. There are over thousand small or large national research laboratories under various Government Departments. Fifty years ago, we imported even paper clips and bicycles. Today we export automobiles and locomotives and perhaps soon aeroplanes. We have made great progress in the fields of Atomic Energy, Space and Agriculture. However the state of education in our universities is pathetically low, in my personal view. Experimental laboratories in our colleges and universities need considerable upgrading. Even the laboratories in most of engineering colleges are quite poor, compared to the average engineering laboratories abroad.
6. In particular, our research workers in the national laboratories do not want to teach in universities and post-graduate teachers do not interact with under-graduate colleges. During 1950s & 1960s a large number of jobs were created for our scientists in national laboratories, Government Departments and public sector undertakings, apart from industries, this is not currently, more so. Students join B.Sc colleges as a last resort. The problem is that we have separated teaching and research. Students do not get exposed to the great excitement of science in colleges.
7. Certainly India cannot progress without science and technology. India is a great nation with a rich culture, philosophy and tradition. The love for learning and scholarship is ingrained in our culture. Perhaps it is even in our genes, due to the richness of our flora and fauna, which has influenced our philosophy and culture. I may quote a few lines from Nehru's convocation address at the Allahabad University, when he said "it is science alone that can solve the problems of hunger and poverty, of insanitation malnutrition, of illiteracy and blind faith, of superstition and deadening customs and traditions, of vast resources going waste of a rich country inhabited by starving millions".

8. India is on a cross road today. The economic liberalization has given us new hopes and challenges, but we need lots of financial resources for developing our infrastructural facilities. We also need to improve our system of education system at all levels, from primary to the post-graduate stages. The improvement of primary level education is the pressing need of India today and we must place highest importance to it. However, in my talk I plan to devote my attention to the science education in colleges and universities.
9. It must be realised that when resources are scarce they should be ploughed in places where there would have a multiplier effect. Separation of teaching and research was done in India soon after Independence, in order to build national capabilities in a variety of areas. Unfortunately, this temporary strategy has been a permanent feature. Today, there is an urgent need for fostering closer interaction between research institutions and universities. Although we have a large number of research laboratories, our research output has been declining in recent years. Industry has not shown any interest to have a close interaction with our national laboratories and universities. Over the last 5 years number of Ph.D. students in various national laboratories as well as IITs, IISc and Universities have decreased by a factor of about 5.
5. Bright students prefer to join medical or engineering colleges and take admission to B.Sc courses as a last resort. Many are joining Bachelor of Computer Science course which is fine, if that is their aptitude, but many of the talented students still prefer to take science at under-graduate level if they are assured of a good education and a good career. Many B.Sc. students join private computer classes offered by NIIT, APTEC, TULIP, C-DOT, etc. and many of them do not concentrate on their B.Sc studies. Overhauling of our under-graduate education on a national scale will take time and money. However, we should seriously consider using multi-media teaching packages for computer aided science education for students as well as teachers. With this in view we have taken a small step at Pune by initiating an Inter-collegiate Diploma Course in Scientific Computing and Applications to be conducted from 5.00 p.m to 7.00 p.m. during the first half of the B.Sc degree course. It is an autonomous

programme with a modest course fee of Rs. 12,000/-. The objective is to give selected under-graduate students necessary computer skills for computer simulation and modelling of selected physical, chemical and biological processes and phenomena. Students will be also taught basic skills of computers such as usage of visual basic, C++, graphics, etc. so that they can either continue to specialize in science stream or enter IT industries after their B.Sc degree. We also plan to give these students a good foundation in core curriculum of science courses.

10. An important question is as to where are the job opportunities for B.Sc students in the country. In a study undertaken by the Indian Academy of Sciences, Bangalore a few years ago it was estimated that about 1000 talented students are needed every year for a career in science at various research institutions and universities. Another 25,000 students take up jobs in various scientific agencies, banks, industry etc. Many become college and school teachers. Considering the same the Academy have proposed a three-stream system of university education in science for meeting the needs of B.Sc students with different aptitude and talent.

11. About hundred thousands students join engineering colleges and about half or one million B.Sc colleges every year in India. There is an urgent need for giving them adequate computer skills because there is a very large need of skilled manpower in the field of Information Technology (IT) nationally and internationally. IT is one of the fastest growing industry in the world today and is likely to bring a revolution in every endeavour of mankind. The Indian Software engineers are highly respected internationally and the world looks at India for meeting IT the manpower needs. There is an unique and rare opportunity for India to become an economic world power by utilizing our 'brain-wealth' or the grey-matter or what I call as India's 'Grey-Gold' or 'Cyber-Gold'. Software exports from India have shown a growth rate of about 50% every year for the last five years reaching about Rs. 10,000/- crores (\$ 2.5 billion) in 1998. Can we sustain it? We require a massive manpower training. Improvement of science education at the under-graduate level will pay India a great

dividend and that is the only way we can hope to aim at the software export target of \$ 50 billion in 10 to 12 years from today. There is no time to loose as the importance of the field of IT has been recognized by all nations in the world today and we may loose our advantage in years to come.

12. As has been recommended by the Indian Academy of Science in a document written in 1994 that we need to overhaul our under-graduate education by a three tier system concentrating on basic courses during the first two years of offering a B.Sc degree or B.Sc applied physics degree. This would indeed be an inspiration for vast majority of our students. However, we must attract the best working environment in our scientific laboratories for both basic as well as applied research. A closer interaction between colleges, universities, research institutions and industries is a must. A group of us have suggested a five year integrated M.Sc programme to be supported by majority of Scientific Departments such as CSIR, DAE, DRDO, DBT, ISRO, etc. Teaching and research would go hand and hand right from the first year. The students will spend the full 5th year working on selected projects in laboratories of research institutions and industries.
13. I would also like to stress that we should take steps to stop mass migration of top talented persons from India. These students, scientists and engineers are indeed our Kohinoor diamonds. We are exporting tens of thousands of our human stars and jewels from India freely. The brain drain continues to increase every year.
14. On the other hand research in our scientific institutions, laboratories and industries is suffering severely due to shortage of skilled manpower. Prof. Megnath Saha cried in 1950 for giving adequate support to universities. Also Prof. C.V. Raman was against setting up of a large number of national laboratories outside the university system but we ignored their views. In 1965 Dr. Bhabha wanted to set up an Inter-University Centre at Ooty in the fields of physics and electronics we were building the Ooty Radio Telescope. He wanted to develop closer interaction between various

universities in Tamilnadu, Kerala and Karnataka. He had obtained a sanction of Rs. 2.00 crores from the Planning Commission. Unfortunately, he met with a fatal accident and the allocated funds got diverted after his death.

15. What is the difficulty if NPL were to select 40 or 50 students from under-graduate colleges and from South Campus and the Delhi University and give them to get practical training while they are pursuing their science education. Same could be done by TIFR and many other research institutions and national laboratories in India. We need to show the students in schools and colleges the great excitement of science and also be willing to put our time and efforts in meeting their career inspiration. Only then we can continue our forward march in various fields of science and technology
