

INDUSTRIAL RESEARCH – ACADEMIA – R&D MANAGEMENT



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I was born on 8th August, 1928 to a middle-class family. My parents had 4 sons and 2 daughters to raise and educate on my father's low monthly salary. We all studied in Board High School, Nidadavol, West Godavari District, Andhra Pradesh. This village had no running water or electricity. I studied with a kerosene lamp. Our batch was the first to write the high school examination in our school, in 1944. There was a function held in our school in late 1944 with the Education Minister of undivided Madras state as the Chief Guest to award a medal to me for topping the pioneer batch in our school. Since all our siblings studied in that school, when I liquidated two plots of land we had in that village, I donated that money to build a set of classrooms, since the class rooms collapsed in a recent cyclone and the students were studying under trees. The classroom building was dedicated to the memory of my late parents, Eleswarapu Sriramamurthy and Eleswarapu Neelaveni.

For Intermediate (or PSU), I went to Government Arts College, Rajahmundry for two years. Some years ago, when this college celebrated its centenary, our Physics teacher contributed a chapter to the commemoration volume. That chapter covered 10 alumni of the College during the past 100 years who made outstanding contributions to India and he included me as one of those ten. The values of a family can move mountains even if money is limited.

COLLEGE

I joined the College of Technology at Banaras Hindu University (BHU) in 1946 and received a B.Sc Tech degree in Glass Technology in 1949. It was a memorable period of BHU, when the founder Pandit Madan Mohan Malaviya and the Vice-Chancellor Dr Sarvepalli Radhakrishnan were staying on the campus. In early 1947, all the national leaders including Pandit Jawaharlal Nehru, Mahatma Gandhi, Sardar Patel, Maulana Abdul Kalam Azad, Sarojini Naidu, Jayaprakash Narayan among others, visited the campus and addressed the students. Dr. Radhakrishnan delivered Gita lectures every Sunday, attended by students and staff. On one occasion, he announced that there will be no Gita lecture next Sunday since he has been asked to speak to the nation at 1130 pm on 14th August 1947, just before Pandit Nehru gave his famous "Tryst with Destiny" lecture just before midnight when India became independent. On a later occasion, Dr. Radhakrishnan announced at a Gita lecture that he was reluctantly leaving the University because Pandit Nehru appointed him as the first Indian Ambassador to Russia. The intellectual ambiance created by luminaries leads the way to following in their footsteps to serve the nation.

As part of my engineering undergraduate education, I had spent summer and puja vacations in industrial training in Ogale Glass Works, Ogalewadi, Maharashtra and in Ganga Glass Works, Balawali, U.P. This was a valuable exposure to actual shop floor industrial operations, which unfortunately is no longer a required component of Indian engineering education.

Recently, by combining the Colleges of Engineering and Technology, BHU Indian Institute of Technology was created. Immediately, BHU IIT Global Alumni Association was formed. In its first meeting in June 2013, I was honored with an Award for Excellence in Research in a memorable function in Bangalore. This was 64 years after my graduation from BHU!

FIRST FACTORY JOB

My first job in 1949 was in the Parry Pottery works in Ranipet, Madras state with a starting monthly salary of Rs.75 plus dearness allowance. I was on shift duty and was supervising from raw materials, processing, fabrication of pottery articles, drying, firing in a tunnel kiln and finally packing for dispatch. An engineer's education is not complete without exposure to these industrial practices, preferably in the early stage of his career. Since I wanted to go abroad for higher studies, I left this job in August 1951.

STUDIES IN USA

I got admission with an Assistantship at the University of Washington, Seattle, USA. I travelled by ship from India and joined the University in September 1951. Since my BHU degree was of 3 years duration, I studied for one year to earn a B.S degree in Ceramic Engineering and after another 15 months, received M.S Degree in Ceramic Engineering.

Soon after arrival, I entered a research paper competition and I won a prize and the paper (my first) was published. I won a prize in same competition in the following year, leading to my second publication. My professors were impressed with this, being the first for the department.

Professor James I. Mueller was my thesis guide and unforgettable mentor at the University of Washington and he enabled me to integrate with the American educational and social scene and to do my best.

I helped a consultant by carrying out the necessary experiments and it was a valuable experience in tackling real world problems, besides giving me a welcome income. An open mind to opportunities is needed to learn.

MY Ph.D.

As I was completing my M.S. degree, I applied to MIT and Pennsylvania State University (Penn State) for Ph.D. admission. Both admitted me and MIT gave a half time Assistantship (\$ 128 per month) and Penn State gave a three quarter time assistantship (\$192 per month). Since, I wanted my wife and daughter to join me from India, I accepted Penn State offer (inspite of the greater reputation of MIT) and joined there for my Ph.D. in January 1954 and my family joined me in December 1954.

I worked with Prof Hummel for a year and published two papers. Then I shifted to Prof. W. Buessem as my Ph.D. thesis guide and worked on "Domain Effects in Ferroelectric Barium Titanate Ceramics". Dr. Buessem was the Director of Siemens

Research in Germany before and during the World War II. He joined Penn State as a Professor in early 1950's. I was his first Ph.D. student. I published two papers from my Ph.D. thesis, one in the U.S. and the other in German in Germany.

INDUSTRIAL RESEARCH

As I was completing my Ph.D. thesis, I applied to four major US companies for a research job. After interviewing, I was offered jobs by all the four. I evaluated them in terms of my priorities and finally accepted the one from Westinghouse Research Laboratories, Pittsburgh, PA headed by Dr. Clarence Zener. I felt that Westinghouse offered better opportunities to learn and grow, though it paid the lowest starting salary of the four offers. I joined in November 1956 and worked mostly in two areas – Ferroelectrics and Solid Electrolytes for Fuel Cells. I came up with a family of Ferroelectrics with higher Curie temperatures than the 560° C which was the limit so far. This breakthrough attracted a lot of international attention. The work on Solid Electrolytes was of great relevance to Westinghouse since work on solid oxide fuel cells was being pursued actively at that time. With excellent mentoring available for me at Westinghouse, not only the quality and relevance of my research on industrially significant problems blossomed but also conveying my research results in the form of publications in reputed journals. In fact, my papers were getting accepted as submitted even in the best Journals.

DILEMMA AND RESOLUTION

Life is a perpetual motion machine. After establishing a successful research career, some things cropped up. We had two more children (a son and a daughter). My wife wanted to raise our children in India to become acquainted with life and relatives in India and that it should be done before they become too grown up to adjust easily. So, she wanted it to happen before end 1963 (when the children were 13, 5 and 4). At that point, Dr. P. K. Kelkar, Director of the newly established IIT, Kanpur visited Carnegie Institute of Technology and Westinghouse Research Laboratories in Pittsburgh (the latter to get an idea of industry oriented research in the US). Dr. Zener wanted me to show Dr. Kelkar around our lab and then Dr. Kelkar impressed us with his vision of the kind of institution that he wants IIT K to be. On his return to Kanpur, he sent me an offer of an Associate Professorship and long letters about why he wants me and others like me to come and join and shape IIT K.

As a follow-up of my brief visit to India in 1960 when I delivered some lectures, I had attractive offers from some of the prominent labs in India. When Mr. Sethuraman of W.S Insulators Ltd, Chennai visited Westinghouse to finalize a collaboration, he met me and wanted me to join them because of my long association with Westinghouse.

Thus, I ended up with four offers in India. Again, by evaluating them using my priority criteria, I chose IIT Kanpur, though again it paid the lowest salary and I had no teaching experience. Again, I am glad that my criteria and choice were right.

Having decided to join IITK, I informed Westinghouse that I am leaving US to return to India. They pointed out that I am fully integrated and very productive in the US and that I will be lost in India. When I did not budge, they said, as a special case, they will give me one year's leave, because they were sure that I will be back within 3 months. I thanked them, but added that I want to get there with both my feet and try my best to settle down. If things did not work out, I hope that either Westinghouse or some other organization in US will hire me. This obviously is due to my desire to serve the nation. Lo and behold, 54 years after 1963, I am still in India.

IIT KANPUR

I reported to Dr. Kelkar at 10 am on 3rd November 1963 to join. He was gracious and emphasized how happy he was about my joining IIT K. After discussing for 30 minutes, he went to a meeting,

to select the first set of Ph.D. students in Philosophy in IIT K. He took me along. I was amazed that when he had a million things seeking his attention in Institution building, he gave enough importance to students' selection. This was the first of several surprises to me about the wonderful person that Dr. Kelkar is.

I never taught before and hence I had to spend a great deal of time preparing for each one-hour class. The students are brilliant and this adds to the challenge.

The faculty became involved in all aspects of institution building and operation. For example, I was made Chairman of Equipment Committee with several members including one from Kanpur Indo-American Program (KIAP). KIAP is a consortium of nine leading universities in the US to help develop IITK. In addition, US Government provided about \$ 10 million for purchase of equipment, to be dealt with by the Equipment Committee. Some of the equipment was for the teaching labs but more of it was for research. In order to make specialized, expensive equipment available to all faculty members, it was placed in Central laboratories instead of departmental laboratories. For example, IITK had the first computer in any educational institution in India and it was a central facility.

As soon as I joined, I was made the Head of the Metallurgical Engineering Dept. Five months after I joined, I was promoted as a full Professor. When Dr. Kelkar created and appointed the first two Deans (one for Faculties and the other for Research & Development), it was a new initiative among the IITs. I was appointed the first Dean of Faculties, with responsibility to hire quality faculty for each department and to look after their needs. As Dean of Faculties from 1966 to 1972, I had played a key role in adding over 200 faculty members to IITK, a large number of them from abroad, mostly USA. For this purpose, I used to make trips to US to meet potential candidates and their referees and to provide information about IITK to them.

As Dean of Faculties, I realized that most of our faculty are trained abroad and have little or no exposure to Indian industry, its level of development, nature of its problems etc. As a solution to these lacunae, a novel programme, High Level Summer Opportunities for Faculty in Industry, was conceived and developed. I went around to various companies to explain the goals of this Programme, which is a win-win for all concerned and then sought some problems the Company would like to have a fresh look at and come up with implementable solutions. Thus, I collected a set of industrial problems, matched them with the background and interests of the faculty and if the identified faculty agrees, his (or her) name is proposed to the Company. The Company then sends an offer to the concerned faculty member. The work gets done, and a report is presented to the Company. Nearly half of the Engineering faculty participated once or more in this Programme in the first few years. This has influenced the teaching material of such faculty and also the projects they assign to students. Many Companies participated in this programme in successive years.

Another major contribution of mine to IITK and Indian academia at large is the introduction of Materials Science as a discipline for teaching and research. It started with a 10-day conference on Materials Science Education at IITK in 1966 with many teachers and also engineers from industry as participants. Three prominent materials science educators from the US had attended. Now Materials Science appears in the curriculum of all engineering colleges in India. I set up an inter-disciplinary programme in Materials Science leading to M.Tech and Ph.D. degrees where the students as well as faculty are drawn from many engineering and science disciplines. This was followed by creating an Advanced Centre for Materials Science to house sophisticated equipment for materials research as a Central facility.

In the early years of IITK, there were not many Ph.D. students, particularly in the Engineering disciplines. Therefore, nearly all the research was carried out by B.Tech and M.Tech students. But the brightness of these students ensured that the quality of research was good and the results of such

work is published in leading international journals. This helped the B.Tech students to get into the best engineering schools in the U.S.

Engineering colleges in India, by and large, use text books written by well-known authors abroad, but reprinted as Indian or Asian editions, and sold at affordable prices. In the early stages itself, IIT K faculty undertook to write text books. This effort was assisted by creating a textbook cell with typists, draftsmen etc. As a pioneer in Materials Science Education in India. I undertook and wrote “Experiments in Materials Science”, together with four of my young colleagues. This book, in cyclostyled form, was used in the one-month summer courses for engineering teachers under the Quality Improvement Programme of the Government of India. The book was published by McGraw Hill Publishing Co. as submitted and with no alterations. It has been used at all leading Universities in the US. Simultaneously, it was brought out by Tata Mc.Graw Hill in India, with support from National Book Trust to market at a lower price. It was soon translated into Portuguese for the South American students. This was the first of 10 books I wrote or edited.

Because of my being away in US from 1951 to 1963, I was practically an unknown person in academic and professional circles in India. However, soon after joining IITK, I was called upon to participate in a number of high level national and international activities, possibly due to the reputation of IITK rubbing off on me. Examples are: the first Science and Engineering Research Council (SERC) of Department of Science and Technology; the first Committee of the Electronics Commission; Indo-US sub-commission on Science and Technology with six members from each country to identify areas of common interest to be carried out by experts in both countries. For example, in the first SERC, there were 2 members from academia out of a total 8 and they were Prof C.N.R. Rao and me, both from IITK. The Working Group chaired by me in the Electronics Commission recommended establishing Central Electronics Ltd., and I had to present it to the Committee of Secretaries and convince them, which approved it and the company came into existence. In the Indo-US Sub-commission on S&T, I was the only non-government member. Once when the sub-commission was meeting in Delhi, Prime Minister Indira Gandhi wanted us to meet her and report the progress of our work. When the Regional Engineering Colleges were completing their first decade, a committee to examine their progress and future directions was appointed, with me as a Member. The Committee made Bharat Darshan visiting all the RECs from Srinagar to Trichy and made recommendations, which were accepted by the Government.

I was also nominated as a Member of Board of Hindustan Zinc Ltd and UP Electronics Corporation, which proved to be a very interesting experience for me.

ANOTHER TRANSITION

By 1981, another transition was surfacing. Since my three children, for whose upbringing in India we shifted from US to India in 1963, have all got their degrees and returned to the US, I suggested to my wife that we also should go back. She was not in favour of it.

At that time, Mr. F. C. Kohli of Tata Consultancy Services, invited me to meet him in Bombay. We had known each other, since Mr. Kohli was actively involved in the development of IITK through his participation in faculty selections, setting up the computer center and taking a number of faculty during summers into TCS. He briefly outlined to me his idea of an R&D Centre in the private domain to carry out meaningful R&D for Indian needs. He mentioned that he discussed this idea with Professors at the University of Waterloo in Canada. He wanted me to participate in this idea. This is the beginning of the next transition in this engineer’s career.

BIRTH OF TRDDC

After the initial discussion with Mr. F. C. Kohli, a team of 3 professors and Deans from University of Waterloo visited India to meet Government officials, business leaders and Tata Management and then submitted a report. I was involved in these discussions. Then Prof. Norman Dahl of MIT was commissioned to prepare a report on private R&D institutions in the US and he covered four of them, following which he visited India for discussions with the Tata Management. I was fully involved in these discussions. There were consultations with the Indian Government at a high level. The Tata people who fully participated in these discussions in 1981 were Mr. J.R.D. Tata, Mr. Nani Palkhivala and Mr. F. C. Kohli. Then I was asked to prepare a final document on the goals, location and modus operandi of the proposed R&D institution. I prepared such a document which was discussed and approved. Since, I was still inclined to shift to US, my wife was persuaded by Tata management about my role. The rest is history.

Thus, Tata Research Development & Design Centre (TRDDC) was born in Pune in 1981 with me as the Founder-Director. The word “Design” was added at Mr. Kohli’s insistence, since research and development are incomplete unless it assumes a form through “Design”.

The mission of TRDDC is “to use the existing knowledge for the benefit of our industry and our people”, in the words of Mr. J. R. D. Tata. Translating this statement into reality was the challenge before me. The tasks undertaken were based on the stated needs of the end user. This required establishing communication with the beneficiaries of our work and develop a partnership relation. The quality of work has to be the best possible which translates into using the best advances in science and technology. For this to happen, one has to have people with a deep understanding of their subject and willing to put in the hard, dedicated work needed to get the desired end results.

The best trained and motivated young people from abroad as well as India were recruited and given maximum freedom to accomplish the best results. Problems to tackle were arrived at by discussions with the end users - Tata Consultancy Services for software and Computer science areas and industries in the TATA group and other private and public-sector companies for others. There were projects funded by Government departments as well as international collaboration projects. The benefits that accrued are new products, improved productivity and reduced energy consumption. A number of patents and published papers in leading journals (many with joint authorship with the beneficiary company) are additional outputs. Based on their work in TRDDC, many people received recognition through election to the prestigious professional bodies, academies here and abroad, awards, publications in leading journals, etc. For example, the benefits which accrued to the beneficiary company were such, that the Chairman of a company included the contribution of TRDDC in his annual report to the shareholders!

As examples of use of science and technology for the benefit of our people (as mentioned in the mission statement), one might cite a low cost, very efficient, well-engineered water filter based on rice husk ash, for the rural people. Another example is low cost decentralized Bio-gas plants using a wide variety of agro-industrial wastes while achieving a high rate of bio gas production by employing specially developed, highly efficient microorganisms.

Some of the other unique features of TRDDC which added to the competent human resources of India are: a number of researchers were encouraged to receive their Ph.D. degrees in India and abroad; a number of faculty from Indian educational institutions served as Consultants on the industrial problems pursued by TRDDC; a number of academics from abroad spent their sabbaticals of a few months to one year at TRDDC.

My gratification is that a wonderful mission statement could be converted into reality with tangible, heartwarming results. The close interactions in accomplishing this with three wonderful mentors – Mr. J R D Tata, Mr. Nani Palkhiwala and Mr. F. C. Kohli – is my eternal memory and reward. For

example, what amazed me about my interactions with Mr. J.R.D. Tata and what I learnt from them was: Considering that he is the Head of over 100 companies, his humility is unbelievable. The undivided attention he gives you when you are discussing something is incredible. The sound advice he gives you based on his vast experience floors you.

SUMMARY

What are the main ideas or leads stand out from this engineer's mind journey. Clearly, a person's success and contribution depends mostly on one's clarity of mind and dedication to quality of work than on one's family limitations. One should always seek and grab opportunities, the more demanding the better. Interacting with young students and colleagues to enable them to reach greater heights is one of the most gratifying satisfactions. Learning from your mentors and mentoring the next generation of achievers is an important goal and contribution. Institution building calls for an open mind, cooperation of all involved, nurturing values, dedication to best quality and meeting or exceeding targets. Value of service to society and of learning takes precedence over monthly income. The latter is likely to follow. Building partnerships is always more fruitful than going solo. Similarly, multi-disciplinarity is the need of the hour than limited expertise.

Lastly, I am grateful for the opportunities available to me, and the wonderful mentors that groomed me and to my family.