Engineering Challenges – A Personal Account

by
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I had a natural inclination for engineering and when I passed Inter Science from Elphinstone College Mumbai, I joined VJTI and obtained my B.E. (Mech & Elec) (Hons) degree with First Rank from Bombay University. At that time VJTI had very good faculty and many of them were picked up for the new IITs being started. To give an example, Dr P. K. Kelkar, head of the Electrical Department was appointed Director of IIT Kanpur, and later Director of IIT Mumbai and awarded the Padma Bhushan.

I went to Imperial College in London for a Master's degree in Electrical Engineering with the Nathubhai Mangaldas Scholarship of Bombay University. I was also awarded the Metropolitan Vickers Scholarship by Imperial College. This made my life in London quite comfortable. After completing my studies with a D.I.C from Imperial College and an M.Sc.(Eng) degree from the University of London, I joined English Electric Co in UK in their Machine Development Department.

Here I had my first lesson in professional responsibility. I was asked to study a report on machine oscillations prepared by the Research Dept. of English Electric as I had worked on a similar problem at Imperial College. It was clear that the research findings were totally wrong and I said so in my draft conclusions. Since I was new, I requested the department head to have my comments issued jointly with another engineer as its conclusions would have serious repercussions. He told me: "If you have any doubt please withdraw your comments, if not, you should not hesitate to take personal responsibility for your conclusions." The comments were issued as a departmental report in my name and there was quite a commotion in the Research Department whose findings had never been questioned before. However in the end they accepted their mistake and officially withdrew their report.

On return to India in 1958I joined the Tata Power Co. One of the first assignments was the modernization of the 6 x 8MW Bhivpuri hydro station that was commissioned in 1922. A systematic study was undertaken by a team, starting with the storage dam, the complete water conductor system, the turbine generators, electric switchgear etc. Based on this, a step by step upgrading program was drawn up. This required an overall view as well as great attention to detail to specify new equipment to fit in with the existing equipment with minimum disturbance to station operation. The dam was strengthened using the Coyne method ;the water conducting tunnel was cleaned of debris and the lining repaired, the steel penstock pipes were cleaned internally and externally and painted with corrosion preventive coal tar paint. New pelton wheel turbines were installed on the old shafts and new windings fitted in the generators raising the station capacity to 6 x 12MW. A completely new control room and outdoor switchyard were also added. The refurbished station gave reliable service at its upgraded capacity for over 30 years. This was an excellent example of life extension of the whole power station at minimal cost.

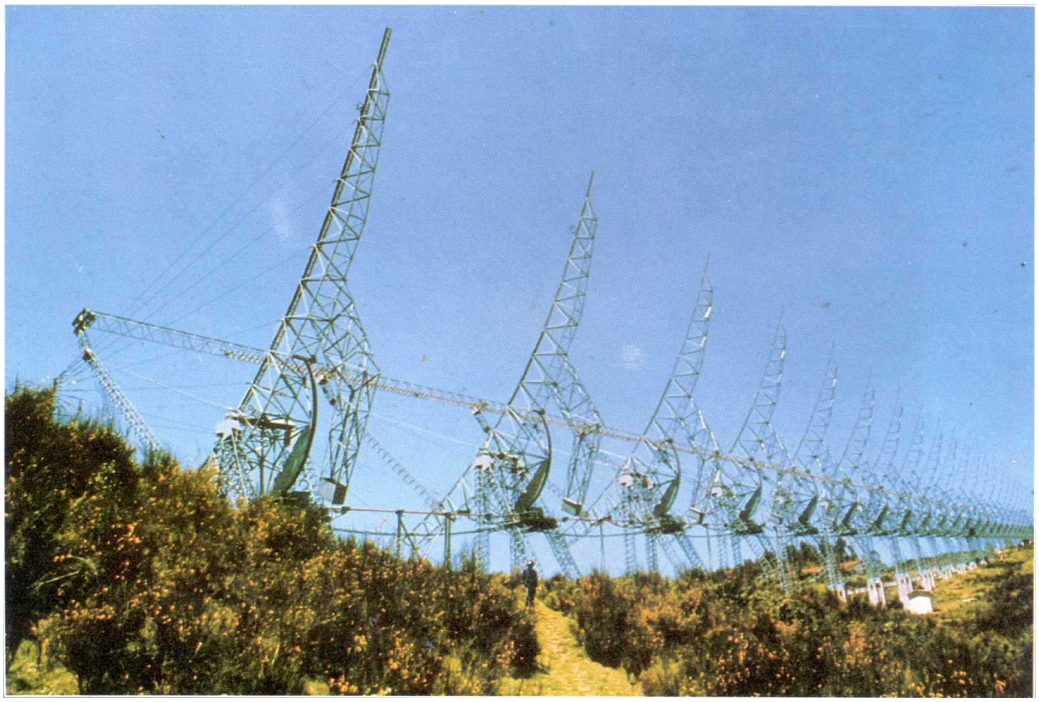
At this time, Tata Power Co decided to add a 150 MW thermal unit (largest in India at the time) to its Trombay station to meet increasing power demand. Ebasco Services of New York were appointed Consultants and a local team, many of them fresh graduates, was assembled to work closely with them. I headed the electrical design group in this team. After the design work was completed, I, as well as many others in the team, were deputed to the project site at Trombay to manage and supervise the construction activities. This combination of design and construction experience was highly beneficial to the young team.

With great foresight in 1962 Tatas decided to start an independent firm of Consultants in partnership with Ebasco named "Tata-Ebasco Consulting Engineering Services" I and other members of the core team were transferred from Tata Power Co to Tata-Ebasco who took on the engineering of the 150 MW Trombay unit and also other r projects such as the 2 x 140MW Dhuvaran station of Gujarat State Electricity Board, projects for other Electricity Boards, many captive power projects and later nuclear power projects for the Department of Atomic Energy. It soon established itself as the premier consulting firm in India. In 1968 Tatas took over the share of Tata Ebasco and the firm became "Tata Consulting Engineers".

TCE also diversified overseas with work in Nepal, Laos, Sri Lanka, Algeria, UAE, Malaysia, Iraq, Iran, Nigeria, Tanzania and others. In Iran TCE had a long term assignment for training of engineers of Tavanir, the Iranian power utility. I spent 6 months in Tehran, to start off the electrical training part of the assignment. It was a novel experience to work in a different country with a different language, culture and work ethics. We had a large team to help Tavanir in design of substations, transmission lines and the operation and maintenance of thermal power stations. Later I was in charge of the Tavanir assignment and had to visit Tehran frequently during the Shah's regime, during the revolution and also after the revolution. The TCE group was drawn from TCE, Tata Power, and some State Electricity Boards, each with different work cultures and it had to be molded into a team. As we worked as a team in close cooperation with the Tavanir staff as well as their management we were asked to continue our work through the regime change in Iran.

TCE specialized in taking up one-off projects under its Special Projects Division that was also under my charge. This required design from first principles and threw up many challenges. One of the first projects in this area was the Equatorial mount radio telescope for the Tata Institute of Fundamental Research (TIFR). The concept required a 530 M long antennae array consisting of 24 parabolic structures each 30 M wide connected by fine stainless steel wires to make up the antennae surface. It was to be placed at a sloping angle of 11 degrees, equal to the latitude of the place and rotated at a speed corresponding to the earth's rotation so as to track the celestial object being studied. A suitable location was found near Ooty in Tamil Nadu.

At a meeting with TIFR, instead of asking Consultants the usual questions about prior experience in telescope design, Dr Homi Bhabha asked our structural design team: "I want this design to be done in India. Can you do it?" After an internal review we accepted the challenge and the design was done in 1963 in close coordination with TIFR keeping all scientific requirements in mind.



Radio Telescope at Ooty

The radio telescope was also fabricated In India, and has operated flawlessly. It is still in operation providing significant research data in radio astronomy.

I was part of an internal study group to consider options for meeting the transmission requirements of Maharashtra as the grid was proving inadequate to meet future demands. The study concluded that a major interconnection between Western and Eastern parts at the next higher voltage level of 400 kV was essential and it would allow bulk power transfer from coal mine-head power stations in Vidharba to load centers around Mumbai and reduce coal transport by rail. The results were presented at the CIGRE conference in Paris in 1974. MSEB decided to go ahead with such an interconnection and TCE was awarded the pioneering task of the design of the 700 km 400 kV transmission system to interconnect Koradi near Nagpur to Kalwa near Mumbai. This was the first time that the 400 kV voltage was introduced in the Indian grid. I was the project manager for this and I went to Bangalore and visited the High Voltage Engineering Department of the Indian Institute of Science and the Central Power Research Institute (CPRI) in Bangalore to see if any test data on 400 kV equipment or lines was available that would help in the design work. However no such help was available and we had to fall back on published data from France and USA as the basis of our work. This illustrates our common problem that investments made in research do not provide results that can be used for practical application.

With TCE's considerable experience of 220 kV systems and using published work for reference we were able to complete the design with confidence. During the design we developed a very neat layout for the 3 bus 400 kV outdoor switch yard using pantograph isolating switches. This design was copied by the Central Board of Irrigation and Power (CBIP) and issued as a 400 kV switchyard reference standard.

TCE continued to be selected for unique project assignments; one such was the Giant Meter Wavelength Radio Telescope (GMRT) built at Narayangaon near Pune for TIFR. This is totally different from the Ooty telescope and has an alt-azimuth mount and comprises 30 fully steerable 45 meter diameter dishes. Of these 14 are located in a central array within an area of 1 sq km and remaining 16 in a Y shaped layout over a large area with an interferometric baseline of 25 km. Each steerable dish is made up of 16 parabolic trusses. All dishes have to move in unison to track the object under observation, and the radio signals obtained are correlated using specially developed software.

Giant Metre Wavelength Radio Telescope (GMRT)

After much brain storming a unique design was evolved comprising “Stretched wire Mesh Attached to Rope Trusses (SMART)”. This resulted in a very light weight and low cost design.

Another challenge, of a different kind, was the first 500 MW thermal power unit in India for Tata Power Co. This was a quantum jump from the 200 MW size that was the highest till then. TCE were appointed consultants and Ebasco Services of New York the review consultants for this World Bank funded project. As a policy, the Tata Management decided to use the services of the review consultants to the minimum to build TCE capability and confidence to undertake such megaprojects.

TCE had to work in close coordination with the Government of India, the Central Electricity Authority and BHEL, as this unit would be the forerunner of a number of 500 MW units in the Indian power sector. BHEL entered into a collaboration agreement with Siemens of Germany for the manufacture of the 500 MW turbo generators; the steam generator was also ordered with BHEL who had an ongoing collaboration with Combustion Engineering of USA. .

500 MW thermal power unit at Trombay

It also provided an opportunity for in depth study of the latest technology available internationally and we selected modern static electronic control systems, automatic turbine start up, computerized data acquisition systems, SF6 circuit breakers, etc. The challenge of undertaking a 'first of its kind' project in the country motivated the whole team to deliver top quality work that was praised by the review consultants in USA. The Unit was commissioned in 1984.

As I moved above the Chief Engineer level there was less involvement in individual projects and more on overall management of the organization and overseeing all 4 offices of TCE and other specialties such as Industrial & Chemical, water supply & sewerage, environmental, construction etc. I also opened new TCE offices at Delhi, Hyderabad and Pune.

Another aspect was manpower planning, recruitment and training and making sure the new staff got assimilated quickly as part of project teams and imbibed the TCE culture. To manage over a 1000 engineers who are all first class graduates from good Universities and have their own specialization requires an open and participative form of management. Further it requires strong coordination to ensure that quality and technical standards are maintained throughout the organization. This was achieved by documenting TCE experience in the form of design guides to be used as the basis for all work. The design guides had to be updated periodically to incorporate latest design trends. We adopted the ISO 9001 Quality Management System that gives a detailed written down procedure to ensure quality. It mandates reference to latest guides and standards and documented checking and verification of all work output, compulsory annual review at CEO level and verification by the Certifying Agency. It required a lot of effort to put in place such a system and get everyone familiar with it, but it has been a great help in ensuring uniformity and quality of output.

Consulting work is very interesting as each project is different, and each subsequent project involves improved technology. Even when projects are similar, the site conditions have to be taken into account and also the requirements of each client who has his own preferences and priorities.

The rapid growth of TCE was also matched by the development of indigenous manufacturing capacity over the same period. From an initial group of 30 engineers TCE grew to over a 1000 by the time I retired in 1998. I am happy to say that the growth story continues and it today has over 4000 engineers and has a large part of its work from overseas operations and continues to maintain its status as the premier engineering consultancy organization in India.