Lifetime Achievement Award Acceptance – 2008-9

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It gives me immense pleasure to receive this award. Life has indeed been generous to me in terms of knowledge, experience and opportunities. I would like to share some of these on this occasion.

My early years

I have worked for over 50 years – the first 18 years with Tata Electric Companies (TCE), and over 30 years with Tata Consultancy Services (TCS), building an IT company. In my work, with both Tata Electric and TCS, my contribution was essentially **in building people and professionals and inducting advanced technologies.** In TEC, we initiated the use of computers and advanced technology tools from the mid sixties. We implemented digital computers for system control and load dispatching in 1968. At that time, UK, Europe and Japan were still working with analog technologies

TCS and Indian IT

TCS was set up in 1968 to partake in the new technology – Information Technology. Even in those early years, we could see the tremendous potential of IT in the automation of manufacturing processes, in building decision and control systems for utilities, and in processing large volumes of data. We were fortunate that we had a very clear assessment of the technology and vision in the early 1970s.

Our Vision at the start

a) People

We recognized at the very start, the need for intelligent, capable and quality professionals. In January 1975, in my address as President of the Computer Society of India, at its annual convention at Ahmedabad, I said, “Many years ago, there was an industrial revolution. We missed it due to reasons over which we had no control. Today, there is a new revolution – a revolution in Information Technology, which requires the capability to think clearly. This we have in abundance. We have an opportunity to participate in this revolution on an equal footing; we even have the opportunity to be leaders.”

b) Rapid obsolescence of Technology

We assessed that technology was developing at a rapid pace and making current technology obsolete in less than 24 months. This meant that we would need to continuously review our knowledge and require continuing education in new technologies.

c) IT is both Hardware and Software

Most of the countries that have successfully built **electronic control and IT industries** are those that have worked both on hardware and software, like South Korea, Malaysia, Thailand, Singapore, Taiwan, and China.

India's place in Software and Hardware

The software export and consultancy services industry that we pioneered in India has done more than creating revenue exceeding US $60 billion, with **$50 billion coming from exports**. The industry has created over two million jobs for professionals and many more at the support level. However, global software and services in 2008 were about **$ 2200 billion**. India accounts for only **2.7%.**

China hardly has any exports in software. However, its software revenue is over **$ 75 billion**. It has written most of the software in Cantonese and Mandarin, and employed extensively in manufacturing, transportation, utilities, business management, retail industry, healthcare, education, e-governance and other areas.

India's hardware industry is about **$ 12 billion,** whereas the global industry was about **$ 1700 billion in 2008**. India's share is 0.7%. China's hardware output is around $_____ billion. It manufactures **over 40 million PCs**. Of this, **25 million is for domestic use**, and 15 million for exports. Taiwan is the world leader in IT and electronics. They even design all machinery and tools for manufacture of electronic components and devices.

The Gap in Indian IT

Coming to India, I would like to submit that the level of computerisation is extremely low. India has hardly any hardware industry. Its software industry is mainly exports-oriented and written largely for English-based applications. I also submit that India needs to use computers extensively in all spheres like Government, Defence, Manufacturing, Finance, Agriculture, Transportation, Education and Retail Services. There are 900 million people who do not speak

English. They need software in Indian languages and hardware at affordable price.

For countrywide application of computers, India must enhance not only its software, hardware and communications resources, but also its professionals in microelectronics.

a) Software

Operating systems, middleware and application software are required in Indian languages. India has over 22 languages.

Considerable work on software in Indian languages is being done at CDAC, IITs, NCST and many other academias. Today we have Open Source Operating System (LINUX), Middleware like FOXPRO and MY SQL and a few applications available in 10 Indian languages.

Regarding applications, Sun Microsystems has granted rights to translate its Office Suite. Similarly, TCS has granted rights for its Financial and Accounting package 'E.X.' But more application packages need to be translated. This needs greater and sustained support on the part of software companies for release of early versions of their packages to be translated to Indian languages.

b) Electronic Hardware

To achieve the desired level of computerisation, **India would need to add 20/25 million PCs a year**. In addition, it would need digital components for Digital Television Sets, Communications including mobile phones, Industrial Controls, Video and Sound Equipment, Automobiles and other industries including Defence.

c) Communications

We had also recommended advancement in 4G wireless communication. The Center of Excellence in Wireless Technology (CEWiT) at IIT Chennai has been assigned the task, and they are on all standards bodies in the world. They have designed advanced simulation and received patents on 4G.

d) Microelectronics Engineers

We need Microelectronics Engineers to make hardware. In 2001, India was producing less than 200 microelectronics engineers, while Israel was producing over 1000, and Taiwan over 3000. TCS and IIT Bombay collaborated to redesign the microelectronics curriculum. This was done and handed over to the Ministry of IT with a request to select 100 engineering colleges to start and upgrade education in microelectronics. The ministry has selected 20 colleges so far, and we produce about 1000 microelectronics engineers.

Manufacture of Electronic Hardware

There are three stages in the manufacture of digital components.

1. **Design Engineering**: This is carried out using special advanced software on computers, **requiring microelectronics engineering skills**.

2. **Embedded Software**: As part of increasing functionality, more and more software is being embedded into the hardware as 'below OS level' software. Microelectronics engineers and Software engineers can be trained to provide such services.

3. **Fabrication Outsourcing**: Fabrication requires silicon foundries. Fabrication facilities are available outside the country (Taiwan, Singapore, Korea, Thailand, and Malaysia), and it can be outsourced.

Fortunately, **the first two stages constitute 80% of the cost of the digital components, for which India can build necessary skills and experience.**

Seven years ago, we said that it should be possible **to assemble fully configured PCs for less than Rs. 10,000.** Last year HCL and Accentiss have placed in the market, fully configured computers with monitors for less than Rs.10,000 a piece.

Building India with IT

Small Scale Needs

India needs to sustain employment and grow in the Small-Scale Industry**,** and Retail stores **that are major providers of employment.** India's model for computerization has to be different from that of the West.

Small Engineering Units

In the city of Coimbatore (South India) there are over 5000 small engineering workshops, each with 10 to 20 highly skilled workers. They engineer and supply automotive components, pumps, motors and castings. These people are highly skilled and innovative. Each piece is designed on the shop floor requiring considerable time and repeated attempts. However, they have limited access to CAD/CAM, Materials Science and Advanced Processes.

TCS has set up a centre for engineering where CAD/CAM and other related software will be made available on dial-up or internet lines. TCS will train these units in the use of relevant software. TCS has worked out an arrangement with **UGS for Design Software** and **AT Kearney for Procurement Solutions**. These units can be made highly productive and cost effective as they have no overheads.

Retail – Small Shops

Shopping malls, where the middle class essentially shop, would continue to grow. We should make it easier for them to grow as they make huge investments in infrastructure, merchandise and services, which are necessary for the country's development. However, the presence and proliferation of shopping malls invariably affects the small shops and stores. In the USA, with the entry of Walmarts, small shops have disappeared from towns.

India has 10 to 12 million small shops. Each is run by the owner and 2 or 3 assistants. Including their families, each shop supports 10 persons on an average. This adds to over 100 million people. The small shopkeepers can play supplementary and complementary roles to the shopping malls. They can use IT **to become convenience and personalized stores**.

At IIT Bombay, the Management Science and Computer Science disciplines have initiated a study leading to a development that will provide:

a) **Inventory Management applications** using **artificial intelligence, algorithms** and innovative techniques to lower inventory and supply chain management costs.

b) System for **Cash Management** to reduce financial layouts and allow for quicker recoveries.

c) Client Relationship Management building on their existing client relationship and providing for personalized services.

Enabling Rural India

Application of Computers and Science

In 1999, the adult literacy figure was 62% for the country and over the previous ten years literacy had increased by 12 or 13%, making reduction in illiteracy 1.2% to 1.3% per year. This rate indicated that it would need another 20 to 25 years to reach literacy of 95 % plus. While the country, both the center and states, had been putting resources in the literacy programme since independence, we decided to carry out a review on our own.

We found that Literacy as defined by National Literacy Mission including reading, writing and number work. It required over 200 hours of classroom work and teaching adults like school children. One had to start from alphabets. We then studied the Cognitive System on how a person learns, recognizes, recalls and retains. We discovered that the common denominator in learning and recognizing are the Visual Images supported with Audio Patterns. The images, both visual and audio, stay in the mind and can be recalled. This also indicated that a better approach to teaching adult illiterates was through recognition of words, rather than a progression from alphabets to words.

The next question was what should be the objective of the exercise. The objective was thus formulated that an adult after training should be able to read a newspaper in his or her own language. We experimented with the size of vocabulary required, and we came to a conclusion that 500 words would be adequate to start reading and understanding the newspaper.

Thereafter, lessons were formulated with the words using the material provided by primers prepared by the National Literacy Mission. The lessons were given at times convenient to the volunteers and comprised of 1½ hr each, thrice a week. The lessons were prepared with the help of linguists and computer socialists, and put on CD ROM to be played on 'Hand- me-down' computers. After about 8 weeks, some of the volunteers started reading. After 10 weeks, they could read the newspaper with a speed of 12-14 words per minute. It was, however, clear that they would continue with the practice of reading on their own after completion of the 10 weeks course, and they would gain further speed and recognition ability.

Since the whole process was founded on the basis of recall of images, the attendees were encouraged to learn writing on their own which meant recall of images and reproducing images. We also emphasized that it didn't matter whether one reproduced images from left to right or vice versa as long as the image was intact. We left out the number work, based on our understanding that almost all adult illiterates in the country could count money and do simple multiplication and division. This ability would get augmented after they improved in reading. The whole process was predicated on the assumption of **empowering the person** with basic skill in reading, and enabling them to work on their own to improve this skills, as well as writing and number work. In short it was an **empowering exercise.**

This experiment has covered almost 1,20,000 people in eight languages. It has established the validity of our assumptions and methodologies.

Our approach was essentially to empower and not to certify. The methodology has been accepted by the National Literacy Mission, Planning Commission and National Knowledge Commission towards achieving literacy.

Engineering Education and Careers

I have been concerned with both **Misplacement** of Engineering graduates and **Mismatch** between the production of and requirement for graduates.

The Mismatch

India is producing **too few Masters and PhDs** in engineering. Innovation, creativity and development of New Technology in Engineering are related to the number of Masters and Doctorate-level professionals that a country produces. India is not producing enough of such people. To increase this number, the country needs more world-class undergraduates comparable to the standards of the Indian Institutes of Technology (IITs). The IITs produce 3000 undergraduates. Of these, 2000 leave the country and another 500 or so move to Management Studies. There are hardly any left for graduate schools to produce world class M.Techs and Ph Ds.

However, there are 50-60 colleges that get students at entry-level, with a score of 85 per cent and above at the 10+2 school leaving level. The background and caliber of these students are similar to those at the IITs. If the quality of undergraduate education at these colleges is upgraded to IIT standards, India could eventually produce more world-class professionals in the engineering disciplines.

We have studied the gaps between these colleges and IITs and prepared a detailed report for the government. (Gaps pertain to Autonomy, Governance, Finance, Faculty, Curriculum, Libraries and Labs.) The State of Maharashtra has taken the lead, and has given autonomy to 4 colleges to start with. We should have these colleges as prototypes and then this approach can be implemented at other 50-60 colleges all over the country. The output then will be 30-40,000 world-class graduates instead of 3,500 as at present.

India produces 3 million graduates. Here is the break-up.

Engineers	350,000 (plus 50,000 diploma holders)
Science graduates	550,000
Arts and Humanities graduates	1,200,000
Commerce graduates	500,000

Out of these 3 million graduates:

- **1/4th are employable with some training** but without any supplementary education
- **another 1/4th are at the bottom, and they can be employed in jobs that are routine** and work up the ladder by learning on the job
- **the remaining 1/2 are good, and can be converted into employable assets.** These people need to be tutored to think of Systems and Subsystems, learn Logic, Programming skills, Rapid Reading, Writing, Speaking skills and some exposure to Operations Research.

We have suggested a 2-semester supplementary education (6 months) programme, plus tutorials, as follows:

- **System Engineering, System Modeling**
- **Logic**
- **Operation Research**
- **Programming Skills, Programming Style, Proof of correctness and Extensive Practice coding.**
- **Rapid Reading to achieve speed of 300 – 350 wpm**; Writing Essays; and **Speaking**.

We need to experiment with 10-15 prototypes to find out the best methodology. Each prototype can comprise 100 students at a selected college. Academics may design the course, syllabus, delivery mode, exercise, etc.

The Misplacement

We have M Tech graduates in mechanical engineering. But they opt for software services rather than manufacturing. There are M Techs in Power Engineering, who are not with Electricity Boards but again with software services. This is happening across disciplines as software offers almost twice the emoluments that these graduates would command in their own fields.

The manufacturing industry has to appreciate that unless they get the higher knowledge that M Techs can provide, they will not be able to meet the future requirements. Electricity Boards have not recruited a single M Tech during the last 10 years – one can see the results. I don't see any reason why the industry cannot match salary levels for these highly educated and knowledge builders. It is an opportunity cost – price of not doing will be obsolescence.

IITs and others producing M Techs have to market their graduates to the industry so that they are employed in their specific disciplines of graduation. Placement officers at these institutes need to make the industry sensitive to this aspect.

Conclusion

In conclusion, it must be emphasised that achieving excellence in education and bringing about changes in continuing education programmes would require **discipline, sacrifice and enhanced resources.** It also calls for **courage and determination to be different**, and to **seize control of direction and destiny**.

We have miles to go.

Thank you.