Eleven Years In Corporate Environment MY EXPERIENCE

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Are you a university professor, or an engineer in industry? Early in my career, I spent sixteen years in university. I am an engineer specialized in power electronics. Since receiving my doctorate degree and spending so many years in university, I always felt that I had a large gap in my education and expertise. My doctoral thesis was rich with analytical work (using complex waveforms, differential equations, matrix algebra,etc.), and simulation results. As a professor in university, I did not have much opportunity to come across with real world practical projects. Naturally, I promoted similar analytical and simulation studies among my graduate students. I advised my students in the lab experiments showing how scope waveforms should look like with a lot of sketches on a black board, but was hesitant to put my hand on the breadboard. As a graduate student, I really did not have much experience to make my hand dirty in fabricating power converters with complex electronic circuits, and solving the real world EMI problems. Of course, I was somewhat nervous with large projects that involved kilowatts or higher level of power. Power Electronics is such an application-oriented practical subject, and these gaps are of no excuse. There was another problem. Power electronics technology was going through fast evolution.

So, in order to supplement my knowledge and expertise, I decided to embark on a new career path in industry – and it was the General Electric Corporate Research and Development (now called GE Global Research Center) in Schenectady, NY. GE is now a global corporation with large number of product departments that use power electronics extensively. GE-CRD was then the world's holy place (often defined as Holy Jerusalem) in power electronics, where power electronics was born and brought up from infancy, through adolescence to the advanced modern age. When I was a young professor in India, the GE-CRD was always in my dream. I heard so much about it, and read books and papers published by GE-CRD engineers who were so renowned throughout the world. How lucky a man could be to have his dream materialize and work in such an exciting environment. It was such a pleasant surprise and excitement when one day I got the letter of appointment from the laboratory manager when I was a faculty member in Rensselaer Polytechnic Institute, NY..

It was a thrilling experience to see so many world's renowned scientists and engineers while walking on the corridor. I was somewhat scared in the beginning and followed my school teacher's advice – "Only listen and do not talk, because talking may expose your ignorance". I was given a desk and chair in the same room with Bill McMurray. Bill was known as the Father of Power Electronics. His brain was very sharp, and each of his papers was classic contribution in power electronics. I was surprised to see how such a world-famous person had barely a chair and desk with a telephone in his office. A lady secretary with a noisy typewriter was also sitting in the same room. Bill was a chain smoker, and the room was always filled with smoke. He rarely spoke with others. The secretary used to call him an "awful person". Although I was sitting next to Bill, I could rarely talk with him. Once I was doing a project with him, and he insisted that I must make appointment for any talk with him. Once I had a ride with him to Auburn (place for thyristor manufacture), but he did not talk to me in the whole journey which lasted about six hours. Bill had only M.S. degree, but later he got honorary doctorate degree from the Concordia University. The GE-CRD hired engineers with degrees from all over the world – Ph.D's from MIT, India, China, Ghana, etc., M.S. from Wisconsin, Virginia Tech, and B.S. from a number of universities. Under one umbrella, all had the title of Electrical Engineer (including myself). Being a university professor, it was a bit humiliating for me.

There were three classes of research projects in GE-CRD: The most prestigious class was called the assessed fund projects, which required invention, analysis, simulation (if needed), and laboratory experimentation. These projects were executed by premier scientists with the funds assessed from the company product departments. The other classes were government and product department funded projects, respectively. Some projects required bench type development work, and these were done mainly by B.S. and M.S. level engineers. Of course, some engineers (like McMurray) were exceptions. I was lucky to get an assessed fund project in the beginning. In fact, my manager gave me the freedom to formulate my own project. This was a big surprise for me. I noticed that most innovative projects terminated only in U.S. Patents and IEEE publications. The company encouraged us to write Patent Disclosure Letters as many as possible, some of which were only conceptual ideas. There was a handsome bonus for a Disclosure Letter if patent application was filed on it. Some of my colleagues working in power electronic circuits had more than 100 U.S. patents.

The company has a large network of product departments, as I mentioned before. Although the purpose of the CRD is to give them technology support, I found that coupling with them was very poor, and hardly any invention was ever translated into a product. Coming from the university, IEEE publication of innovative work was very

Fig.1 The author (second from right) working in GE research laboratory for EV project with fellow engineers

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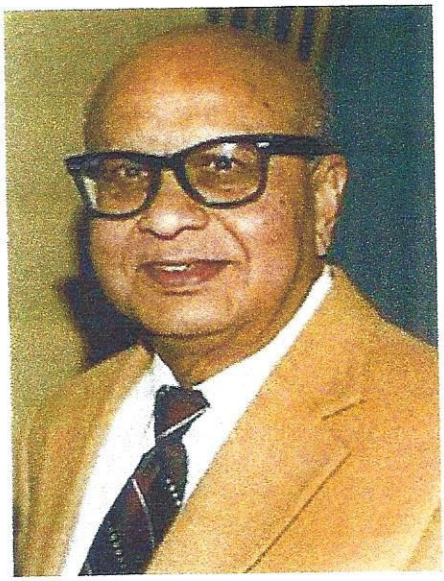

tempting for me. However, publications were discouraged, and were often delayed until the patent was approved. There was fear that competing companies might steal our ideas and use in their products. Each publication required approval by the hierarchy of company managers, that caused long delay and frustration. In university, we follow "publish or perish" principle, where papers are often sent for publication before even completion of the project. But in industry, the principle is opposite, i.e., "publish or survive". This means that you will survive in your job if you avoid hasty publication without regular approval. I estimated that I could almost double my publication rate if there was no company restriction. Once my manager called me in his office and indicated that I was wasting company time by writing too many IEEE papers. However, I knew in the depth of my mind that IEEE papers were extremely important in the long-term growth of career.

While working in GE-CRD, I completed my first book *Power Electronics and AC Drive* (Prentice Hall, 1986). This was not easy while working full time in a company environment. While applying for the company approval for its publication, I had a hard time with the manager. His complaint was that I had taken a lot of company time to write the book. I had difficulty in convincing him that it was written in my home in the weekends and holidays, and this was the reason it had taken three years to complete it. Of course, I had to steal company time occasionally to complete the book.

As an individual researcher, I kept a low profile most of the time. I learnt this from Bill McMurray whom I considered as Guru of my life. I also learnt that research ideas do not necessarily come within the 8AM-5PM work day in office. The thoughts linger most of the time beyond the office hours, and often new ideas come when I am taking bath, walking alone in the evening, or even in the midnight when I suddenly wake-up with the flash of new idea. There is no difference between scientific research and transcendental meditation.

The externally funded projects with deadlines for completion were very demanding. If a project required study of background fundamentals, there was no company time allotted for it. It had to be done in the evening or weekends which we were supposed to spend with our family. Sometimes, meeting the project deadline required a lot of extra hours in office. We had to fill up time card every week for our work. Allocation of company time for the projects was often a difficult task. If I spent two hours in library, or three hours for a doctor's visit, often we had to lie on the time card. I spent a considerable amount of time in GE for DOE (Department of Energy) sponsored electric and hybrid vehicle projects. I became the principal engineer for EV microcomputer control without knowing a-b-c of microcomputer.

Microcomputer/DSP hardware and software were radically different subjects from power electronics. I had to study the new technology, understand it thoroughly, and then design and test the system so that the prototype EV operated satisfactorily before delivering to the customer within the deadline. Of course, I had a technician to help me. This was the most strenuous time in my career. I spent weekends and many sleepless nights in my home for the study, and had hardly any time left for the family. Once our newly-designed EV drive was undergoing test on a dynamometer in Detroit. One night, my manager called me home at 1:00 AM and told that the drive was having an instability problem while accelerating, and I need to come to Detroit in the morning to fix the problem. I lost sleep in the remaining night thinking all the time how to solve the problem. I came to Detroit and solved the problem by canceling the software compensator with an inverse analog compensator, and then connecting an analog compensator in series. Although it was a brute-force method, everybody was happy when the problem disappeared. Finally, when the project was completed successfully, it was a tremendous satisfaction. It is interesting to mention here that Queen Elizabeth II request-

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ed a demonstration in UK for our newly designed EV (ETV I) . I may also mention here that the last project which I did in GE was the IPM (interior permanent magnet) machine drive for EV (ETXII). People in those days thought that it was crazy to use IPM machine for EV drive, where everybody else was using induction machine. Later, IPM machine-based EV/HV drive was accepted all over the world.

Practical projects like these gave me a lot of experience, and confidence in designing, fabricating and testing of large systems with responsibility and gain hard core specialization in power electronics. The experience accumulated with the interaction of projects in different product departments. Large government funded projects required a lot of team effort. Team work is very painful for professors who are normally very individualistic. I found that the lab technicians were very smart, and their help is extremely important for success of the projects. Occasionally, my manager walked in my office, and I was so happy to show him the excellent simulation result of the drive which I was developing. However, he would indicate that he did not trust the simulation results, but would only trust when he saw the actual drive was running in the laboratory.

Once in a month by rotation, the senior laboratory manager used to invite us for lunch, where we were supposed to describe our project without any audio-visual aids. Suffice it to say that there was no pleasure in such lunches.

In principle, the company had the policy of "parallel ladder" career path, where the researchers and managers could compete in parallel path for position and salary. However, hardly it existed in practice. Senior managers belonged to an elite class with power, status and compensation. In comparison, most of the researchers were considered as second class citizens. However, the scenario was entirely different when we went outside the company. The GE scientists/engineers were highly respected throughout the world. It is mainly their contributions that helped to make the power electronics technology so rich today. The IEEE conferences in this area were dominated by the contributions of large corporations , and we were treated as superstars everywhere.

The company had the policy of hiring engineers with degrees from all over the world, as I mentioned before. A doctorate from MIT, for example, could negotiate a much higher salary in the beginning than that of a doctorate from India. There was a system of totem pole evaluation annually, where all the engineers were placed in serial rank according to performance, and the salary raise depended on the totem pole position. This means that it was possible for the engineer from India to get higher salary than that from MIT after a few years. I heard that the company maintained a secret computer program for every engineer, where the information related to his marriage, buying a house, birth of children and getting admitted in school, etc. were continually fed. The main objective was that if you were more settled (with less chance of jobswitch), your salary raise would decrease irrespective of your position in the totem pole. Every person had a "price tag" around his neck, and the question was always asked "are you disposable?" This theory of disposability made the scientist's job more stable than that of manager's. During my eleven years, I found around ten managers to come and go. This was the reason why some managers tended to be ruthless to show their performance. Whatever may be the totem pole position and the result from the computer program, the salary raise tends to dry up after a number of years. You tend to get high raise early, small raise later, and then no raise at all for years in spite of your great performance. This is the most painful stage in the career. The company always likes to get rid of older fat-salaried engineers and then hire lean-salaried young engineers cleverly avoiding the age discrimination lawsuits. If you think that you are very valuable to the company, you can play a trick and sometimes it works. You try to get a job interview outside (easy for a GE engineer), get an offer with higher salary, and then bargain with your manager. This is, of course, very unpleasant and risky. However, I found that there was only one exception. In CRD, we had a Noble Laureate who was the show-piece of the company to the outside world. Every year, the company Vice-President will go to him and ask how much raise he wants.

There was one very good thing with a job in a large corporation. The company's health and pension benefits were very liberal. If you retire from the company with lengthy service, they will bear most of your health cost (including hospital cost) for the remainder of your life. The pension benefit goes up exponentially with length of service, and you could live a very comfortable life after retirement. I found hardly anybody quitting the company job. However, this scenario was changing rapidly in recent years.

While the company work was very exciting with large project experience, and highly prestigious in the outside world, the scenario started changing in the 1980's because of Japanese competition. These were the days of Jack Welch (often called Neuron Jack), when the company culture was changing rapidly. Japan was dominating the world in manufacturing power electronic equipment with higher quality and lower price, and it became a challenge to U.S. corporations like GE. Japanese engineers from Hitachi, Toshiba, Mitshubishi used to routinely visit GE research laboratory. Suddenly, the door was slammed against them. Once I arranged the visit of Dr. Akira Nabae (most eminent engineer in Japan) from Toshiba, and he came to Schenectady, but he was denied visit to the laboratory in spite of prior approval. What a humiliation! The managers in the company were under high pressure to accelerate the productivity. Finding the financial resources was normally manager's responsibility, but now the researchers were under tremendous pressure to find funded projects. It was suddenly chaotic everywhere. The company started emigrating the manufacturing units outside the country to decrease the labor cost. The slogan everywhere was "emigrate or evaporate". After my visit to Japan [1], I found that Japanese engineers and managers were highly disciplined with total dedication to the company work, but this was somewhat lacking in USA. The Japanese management style was unique that promoted loyalty and friendliness among all in the work environment. While visiting Toshiba Fuchu Works (research laboratory) in Japan, once I found that the top manager was working with the workers in ordinary work clothes. It was amazing to me. The R&D work in Japanese companies, unlike that of us, was closely tied with the product development. The additional advantage is that the country being so small, the R&D center and product departments are in close proximity.

Why did I leave GE after eleven years? I found that my expertise in power electronics had improved significantly due to blending of practical experience with my theoretical knowledge. Although I climbed high in the totem pole, my salary raise practically stopped in the latter years. I needed to reestablish my full self-esteem which was shattered so much in the company environment. In the mean time, I gained tremendous visibility in the world because of my books and publications. I thought it was the right time for me to migrate to the prestigious university job where I really belonged. One fine morning, I got a call from the University of Tennessee with the invitation to visit the campus, where I was offered the Endowed Chair position. It was difficult for me to resist the temptation of such a handsome salary with the initial tenure that was so rare in the academic community.

References

[1] B. K. Bose, "What I saw in Japan", Guest Editorial, IEEE Trans. on Ind. Appl., vol.24 , pp. 545-547, July/August 1988.