

CREATIVITY – A PERSONAL CHALLENGE

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Born to nearly illiterate parents on the wrong side of the border, and starting my life from a refugee camp, I rose to receive awards from three different Prime Ministers! Here I share with the reader my life story with the hope that it will inspire the younger generation to challenge themselves at every stage and convert adversity into advantage, instead of cribbing about inadequacy of resources, facilities and opportunities.

As a three year old child, living in a refugee camp in Hoshiarpur, I overheard my father thanking God. I asked him what he was thanking God for when we did not even know where the next meal would come from. He answered simply, “Son, we are alive, isn’t that sufficient?” . That bottom line has stayed with me all my life. I realized that God gave us life and the rest is in our hands; no excuses!

Luckily, the Government gave us some refugee grant and the Sanatan Dharam Higher Secondary School waived all tuition fees. Never mind if I had to walk several kilometers daily to the school without proper shoes. One day, during morning prayers in the school, a guest lecturer told us that as physical strength can be increased by means of regular physical exercises, intelligence could be increased by intellectual exercise; nobody is born intelligent. This appealed to me instantly. I started challenging myself intellectually. Playing with numbers, I developed ‘magic tables’ to entertain myself as well as my classmates. I turned adversity into an advantage. Having no entertainment at home, I engaged myself with mathematical challenges that made me excel not only in mathematics but also everything logical.

At the end of the 7th grade, during vacation time, when challenged by my brother who would not let me play, I took up the 8th grade Mathematics book, taught myself from the text, and solved all exercises in two weeks' time. This not only took my brother off my back (he could no longer stop me from playing) but also led to self discovery. I realized that I did not need a teacher. With the resultant self confidence, despite my spending evening hours to play cricket for my school, I secured 5th rank in the Punjab University in my Higher Secondary examination.

However, the future was bleak because my father could not afford to send me to college. But then, as the saying goes, God helps those who help themselves. The Government introduced the 'Government of India Scholarship' for life for the first ten rank holders of every university in the country (In 1961 there were very few universities in the country). So suddenly my higher education right up to PhD was taken care of.

I wanted to pursue my career in Mathematics and Physics. However, I was persuaded to take up Engineering for its lucre. I joined Punjab Engineering College Chandigarh in Mechanical Engineering but my mind was always in research. During the summer vacation after 3rd year, we visited Bangalore on an educational tour. That is when I discovered the Indian Institute of Science (IISc). It was the place I had been always looking for. Fortunately, I got selected to do my ME degree in the Department of Internal Combustion Engineering without any formal interview or test. During my stay at IISc, I developed great interest in vibrations as well as mathematics.

In the 4th semester, I was asked to work on analysis and design of mufflers for the engine exhaust noise control. However, acoustics of noise control had not been taught in the class. In fact, it was not a part of the curriculum those days. I had the option to request for a change in the project. However, I decided to take it up as a challenge. I went to the library, selected a book on 'Fundamentals of Acoustics' and gave myself a crash course in acoustics. I read the book by Kinstler and Frey cover to cover and solved most of the problems. Then I did a literature survey of the journal papers available in the area of muffler acoustics. I realized that very little had been done on rational synthesis of

exhaust mufflers. The normal practice those days was one of trial and error. I felt intuitively that I could do better than that. Over the next three months, making use of mathematical induction, electro-acoustic analogies, combinatorics, and heuristics of matrix multiplication (all self-taught), I developed an algebraic algorithm by virtue of which I was able to write out the expression for Insertion Loss of a given linear dynamical filter, without having to write and solve the governing equations simultaneously. This algebraic algorithm was not only a break-through for analysis of one-dimensional filters but also for rational synthesis of vibration isolators as well as exhaust mufflers. Had I not challenged myself, I would have ended up making, at best, a small incremental contribution to the field. Instead, I developed a niche for myself.

I was offered a lectureship in the Department without any interview. In fact, a supernumary post was created for me, waiving off the requirement of a PhD for the lecturer's post. Based on extensions of my algorithm, I got my PhD degree and was awarded the Science Academy Medal for Young Scientists in Engineering Sciences for the year 1975. I received it at the hands of Mrs. Indira Gandhi, the then Hon'ble Prime Minister of India.

During the next seven years, I worked on analysis of commercial mufflers, most of which make use of perforated elements. This posed a formidable challenge. In association with one of my PhD students, I developed a distributed parameter approach along with eigen analysis of perforated element mufflers. A paper based on this work was adjudged the best paper in the world in Muffler Acoustics by Nelson Industries in USA, and we got the Nelson Acoustical Paper Award (First Prize) in 1984. Based on this break-through, I got two projects from the Volkswagen Foundation, Germany, and published a few papers that have been cited widely.

I had my first sabbatical at the Institute for Technical Acoustics, Technical University of Berlin during 1979-80, where I gave a course on a muffler acoustics in English. I did not know much of German and my audience were not proficient in English. So, I used to prepare and hand over Xerox copies of the same one week in advance in English. These

sets of notes became the first draft of a monograph. Thus, I converted a problem into an opportunity. I improved the notes over the next few years and finally it was published by John Wiley, New York, in 1987. This monograph has remained till today the only book on this subject, and has been cited in nearly all papers that have appeared in journals during the last 25 years. (Incidentally, its second edition is under preparation and may be published by John Wiley, Chicester, UK in 2014).

Around the same time, I received the 'Shanti Swarup Bhatnagar prize in Engineering Sciences' for the year 1986 at the hands of Shri Rajiv Gandhi, the then Hon'ble Prime Minister of India, Fellowship of the Indian National Science Academy (1987), Indian Academy of Sciences (1987) and the newly established Indian National Academy of Engineering (1987).

In 1988, I was approached by DRDO to work on acoustic stealth for underwater vehicles. This was an entirely new field but then I took up the challenge and eventually developed design guidelines for the stealth linings for submarines. The graphical user interface (GUI) as well as the codes for analysis of these resonator linings were passed on to the Indian Navy. This and some other associated pieces of research got me the coveted DRDO Academic Excellence Award for the year 2009 at the hands of Hon'ble Prime Minister of India, Dr. Manmohan Singh.

Incidentally, I have always worked on practical problems. It is more challenging, yet it is more satisfying to an engineering scientist at the end of the day. I have carried out more than 100 consultancy projects during the last four decades, apart from helping DRDO and the defense forces.

Concurrently, I have been active in the environmental noise control. In fact, I have been Chairman of the National Committee for Noise Pollution Control, which advises the Central Pollution Control Board, the executive wing of the Ministry of Environment and Forests. Since its inception in 1998, based on this committee's recommendations, the

Ministry of Environment and Forests has issued Gazette notifications for the control of noise from diesel generators sets, portable gensets, automobiles, fire crackers, public address systems, etc. This work has been recognized recently by the Government of Madhya Pradesh with the Pt. Jawaharlal Nehru National Award in Engineering and Technology for the year 2010. I received this prestigious award recently from Mr. Vijay Vergeeya, Minister of Science and Technology of the Government of Madhya Pradesh.

Arising out of all these personal experiences, there are a few observations that I would like to share with the reader:

1. Be resourceful. The best of science was not created by scientists with great resources. In fact, I often turned the lack of resources into a challenge and the result was amazing. A fellow scientist from USA once remarked, “But then, you had the advantage of adversity!”.
2. Everybody wants to work at, or be associated with, a world class Institute like Indian Institute of Science. Well, IISc is what it is today because of its outstanding alumni. Why don't we aim at excelling ourselves, so that the Institute's name shines further. Let us rise to a level that the Institute feels proud of us.
3. If you enjoy your work you will never feel tired. I proved this to myself again and again in my life. As per the Science of Psychology, a man can work 24 hours a day provided he is not doing what he is obliged to do. Enjoy the process of research; do not make it a job. Work does not kill, stress does; and stress is a state of mind, an attitude.
4. Creativity increases as we think deeper and deeper, and this depth can be achieved by thinking about a problem undisturbed for long hours at a stretch (no coffee breaks). It was this kind of long, uninterrupted sittings in the library that resulted in development of the algebraic algorithm for analysis of one dimensional acoustic filters and vibration isolators at the start of my career.
5. When you listen to a teacher in the class you may not grasp or retain everything. However, if the teacher tells you to read yourself what he is going to teach the

next day, you will be alert in the class next day to clarify your doubts, and when teacher touches upon those points you will never forget the answers. This is what I do in my classes. My student, incidentally, discovers his potential and gets ready for research by the time he finishes the course.

6. Often students complain about a particular teacher being too harsh in marking. However, I told myself in similar circumstances that the teacher may deduct more marks for a mistake, but if I did not make any mistake, what could he do? This led me to strive for perfection. Which resulted in self confidence, self esteem and creativity.
7. In the long run, clarity about basic principles, laws and concepts is more important than cramming for the examinations. Concepts remain with you for a long time and, during spells of deep extended thinking, result in creativity.