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Emancipators

On Republic Day 1990, the nation celebrated the success of its missile programme. I was conferred the Padma Vibhushan along with Dr Arunachalam. Two of my other colleagues—JC Bhattacharya and RN Agarwal—were also decorated with the Padma Shree awards. It was the first time in the history of free India that so many scientists affiliated to the same organization found their names on the awards list. Memories of the Padma Bhushan awarded a decade ago came alive. I still lived more or less as I had lived then—in a room ten feet wide and twelve feet long, furnished mainly with books, papers and a few pieces of hired furniture. The only difference was at that time, my room was in Trivandrum and now it was in Hyderabad. The mess bearer brought me my breakfast of idlis and buttermilk and smiled in silent congratulation for the award. I was touched by the recognition bestowed on me by my countrymen. A large number of scientists and engineers leave this country at their first opportunity to earn more money abroad. It is true that they definitely get greater monetary benefits, but could anything compensate for this love and respect from one's own countrymen?

I sat alone for a while in silent contemplation. The sand and shells of Rameswaram, the care of Iyadurai Solomon in Ramanathapuram, the guidance of Rev. Father Sequeira in Trichi and Prof. Pandalai in Madras, the encouragement of Dr Mediratta in Bangalore, the hovercraft ride with Prof. Menon, the pre-dawn visit to the Tilpat Range with Prof. Sarabhai, the healing touch of Dr Brahm Prakash on the day of the SLV-3 failure, the national jubilation on the SLV-3 launch, Madam Gandhi's appreciative smile, the post-SLV-3 simmering at VSSC, Dr Ramanna's faith in inviting me to DRDO, the IGMDP, the creation of RCI, Prithvi, Agni...a flood of memories swept over me. Where were all these men now? My father, Prof. Sarabhai, Dr Brahm Prakash? I wished I could meet them and share my joy with them. I felt the paternal forces of heaven and the maternal and cosmic forces of nature embrace me as parents would hug their long-lost child. I scribbled in my diary:

Away! fond thoughts, and vex my soul no more!
Work claimed my wakeful nights, my busy days
Albeit brought memories of Rameswaram shore
Yet haunt my dreaming gaze!

A fortnight later, Iyer and his team celebrated the awards for the missile programme with the maiden flight of Nag. They repeated the feat again on the very next day, thus testing twice over the first Indian all-composite airframe and the propulsion system. These tests also proved the worth of the indigenous thermal batteries.

India had achieved the status of having a third generation anti-tank missile system with 'fire-and-forget' capability—on par with any state-of-the-art technology in the world. Indigenous composite technology had achieved a major milestone. The success of Nag also confirmed the efficacy of the consortium approach, which had led to the successful development of Agni.

Nag uses two key technologies—an Imaging Infra Red (IIR) system and a Millimetric Wave (MMW) seeker radar as its guiding eye. No single laboratory in the country possessed the capability of developing these highly advanced systems. But the urge to succeed existed, which resulted in a very effective joint effort. The Semi Conductor Complex at

Chandigarh developed the Charge Coupled Devices (CCD) array. The Solid Physics Laboratory, Delhi, made the matching Mercury Cadmium Telluride (MCT) detectors. The Defence Science Centre (DSC), Delhi, put together an indigenous cooling system based on the Joules Thomson effect. The transmitter receiver front end was devised at the Defence Electronics Application Laboratory (DEAL), Dehra Dun.

The special gallium arsenide gun, schottky barrier mixer diodes, compact comparator for antenna system—India was banned from buying any one of these high technology devices, but innovation cannot be suppressed by international restrictions.

I went to Madurai Kamaraj University the same month to deliver their convocation address. When I reached Madurai, I asked after my high school teacher Iyadurai Solomon, who was by now a Reverend and eighty years old. I was told that he lived in a suburb of Madurai, so I took a taxi and looked for his house. Rev. Solomon knew that I was going to give the convocation address that day. However, he had no way of getting there. There was a touching reunion between teacher and pupil. Dr PC Alexander, the Governor of Tamil Nadu, who was presiding over the function, was deeply moved on seeing the elderly teacher who had not forgotten his pupil of long ago, and requested him to share the dais.

"Every convocation day of every University is like opening the floodgates of energy which, once harnessed by institutions, organ-izations and industry, aids in nation-building," I told the young graduates. Somehow I felt I was echoing Rev. Solomon's words, spoken about half a century ago. After my lecture, I bowed down before my teacher. "Great dreams of great dreamers are always transcended," I told Rev. Solomon. "You have not only reached my goals, Kalam! You have eclipsed them," he told me in a voice choked with emotion.

The next month, I happened to be in Trichi and used that opportunity to visit St. Joseph's College. I did not find Rev. Father Sequeira, Rev. Father Erhart, Prof. Subramanyam, Prof. Iyyamperumal Konar, or Prof. Thothathri Iyengar there, but it seemed to me that the stones of the St. Joseph's building still carried the imprint of the wisdom of those great people. I shared with the young students my memories of St. Joseph's and paid tribute to the teachers who had moulded me.

We celebrated the nation's forty-fourth Independence Day with the test firing of Akash. Prahlada and his team evaluated a new solid propellant booster system based on a composite modified double base propellant. This propellant with its unprecedented high energy properties was crucial in assuring the long-range surface-to-air missiles. The country had taken an important step in ground-based air defence of vulnerable areas.

Towards the end of 1990, Jadavpur University conferred on me the honour of Doctor of Science at a special convocation. I was a little embarrassed at finding my name mentioned along with that of the legendary Nelson Mandela, who was also honoured at the same convocation. What could I possible have in common with a legend like Mandela? Perhaps it was our persistence in our missions. My mission of advancing rocketry in my country was perhaps nothing when compared with Mandela's mission of achieving dignity for a great mass of humanity; but there was no difference in the intensity of our passions. "Be more dedicated to making solid achievements than in running after swift but synthetic happiness," was my advice to the young audience.

The Missile Council declared 1991 the Year of Initiative for DRDL and RCI. When we chose the route of concurrent engineering in IGMDP, we selected a rough track. With the completion of developmental trials on Prithvi and Trishul, our choice was on test now. I exhorted my colleagues to commence user trials within the year. I knew that it was going to be a tough task, but that was not going to discourage us.

Rear Admiral Mohan retired and his deputy, Kapoor, was to take over Trishul. I had always admired Mohan's understanding of missile command guidance. This sailor-teacher-scientist could outwit any other expert in the country in this field. I will always remember his candid exposition of various aspects of the Command Line of Sight (CLOS) guidance system during the Trishul meetings. Once, he showed me a verse that he had composed to highlight the woes of an IGMDP Project Director. It was a good way of letting off steam:

I*mpossible timeframes,*
PERT charts to boot
Are driving me almost crazy as a coot;
Presentations to MC add to one's woes,

If they solve anything, Heaven only knows.
Meetings on holidays, even at night,
The family is fed up,
And all ready to fight.
My hands are itching
to tear my hair —
But alas! I haven't any more to tear ...

I told him, "I have handed over all my problems to my best teams in DRDL, RCI, and other participating labs. That has given me a full head of hair."

The year 1991 began on a very ominous note. On the night of 15 January 1991, the Gulf War broke out between Iraq and the Allied Forces led by the USA. In one stroke, thanks to satellite television invading Indian skies by that time, rockets and missiles captured the imagination of the entire nation. People started discussing Scuds and Patriots in coffee houses and tea shops. Children began flying paper kites shaped like missiles, and playing war games along the lines of what they saw on American television networks. The successful test firing of Prithvi and Trishul during the course of the Gulf War was enough to make an anxious nation relax. The newspaper reports of the programmable trajectory capability of the Prithvi and Trishul guidance system, using microwave frequencies in virtually unjammable bands, created widespread awareness. The nation was quick to draw parallels between the missiles operational in the Gulf War and our own warhead carriers. A common query I encountered was whether Prithvi was superior to a Scud, whether Akash could perform like a Patriot, and so on. Hearing a "Yes" or a "Why not?" from me, people's faces would light up with pride and satisfaction.

The Allied Forces had a marked technological edge, as they were fielding systems built using the technologies of the eighties and nineties. Iraq was fighting with the by-and-large vintage weapon systems of the sixties and seventies.

Now, this is where the key to the modern world order lies— superiority through technology. Deprive the opponent of the latest technology and then dictate your terms in an unequal contest. When the Chinese war

philosopher, Sun Tzu ruminated over 2000 years ago that what matters in war is not decimating the enemy army physically but breaking his will so as to make him concede defeat in the mind, he seems to have visualized the domination of technology in the twentieth century theatres of war. The missile force coupled with the electronic warfare used in the Gulf War was a feast for military strategic experts. It acted as a curtain-raiser for the twenty-first century war scenario with missiles and electronic and information warfare playing the lead roles.

In India, even today, the term technology, for most people, conjures up images of smoky steel mills or clanking machines. This is a rather inadequate conception of what technology denotes. The invention of the horse collar in the Middle Ages led to major changes in agricultural methods, and was as much a technological advance as the invention of the Bessemer furnace centuries later. Moreover, technology includes techniques as well as the machines that may or may not be necessary to apply them. It includes ways to make chemical reactions occur, ways to breed fish, eradicate weeds, light theatres, treat patients, teach history, fight wars, or even prevent them.

Today, most advanced technological processes are carried out far from assembly lines or open hearths. Indeed, in electronics, in space technology, in most of the new industries, relative silence and clean surroundings are characteristic, even essential. The assembly line, with the organization of armies of men, to carry out simple, routine functions is an anachronism. Our symbols of technology must change before we can keep pace with changes in technology itself. We should never forget that technology feeds on itself. Technology makes more technology possible. In fact, technological innovation consists of three stages linked together in a self-reinforcing cycle. First, there is the creative stage, with the blueprint of a feasible idea. This is made real by its practical application, and this finally ends in its diffusion through society. The process is then complete; the loop is closed when the diffusion of technology embodying the new idea in its turn helps generate new creative ideas. Today, all over the developed world, the time gap between each of the steps in this cycle has been shortened. In India, we are just progressing towards that stage—closing the loop.

After the Gulf War concluded with the victory of the technologically superior Allied Forces, over 500 scientists of DRDL and RCI gathered to discuss issues that had emerged. I posed a question before the assembly: was technology or weapon symmetry with other nations feasible, and if so, should it be attempted? The discussion led to many more serious questions, such as, how to establish effective electronic warfare support? How to make missile development proceed apace with the development of equally necessary systems like the LCA; and what were the key areas where a push would bring progress?

At the end of a lively discussion spread over three hours, the consensus emerged that there was no way to redress asymmetry in military capability except to have the same capability in specific areas as your potential opponent. The scientists vowed to achieve a reduced CEP in the accuracy of Prithvi's delivery, perfecting the Ka band guidance system for Trishul and realising all carbon-carbon re-entry control surfaces for Agni by the end of the year. The vow was later fulfilled. The year also saw tube-launched Nag flights, and the manoeuvre of Trishul at seven metres above sea level, at speeds which exceeded three times the speed of sound. The latter was a breakthrough in the development of an indigenous ship-launched anti-sea-skimmer missile.

The same year, I received an honorary degree of Doctor of Science from the IIT, Bombay. In the citation read by Prof. B Nag on the occasion, I was described as "an inspiration behind the creation of a solid technological base from which India's future aerospace programmes can be launched to meet the challenges of the twenty-first century". Well, perhaps Prof. Nag was only being polite, but I do believe that India will enter the next century with its own satellite in geo-stationary orbit 36,000 km away in space, positioned by its own launch vehicle. India will also become a missile power. Ours is a country with tremendous vitality. Even though the world may not see its full potential or feel its full power, no one dare ignore it any more.

On 15 October, I turned sixty. I looked forward to retirement and planned to open a school for the less privileged children. My friend, Prof. P Rama Rao, who was heading the Department of Science and Technology in the Government of India, even struck up a partnership with me to establish what he called the Rao-Kalam school. We were unanimous in our opinion that carrying out certain missions and reaching certain milestones, however important they may be or however impressive they might appear to be, is not all there is to life. But we had to postpone our plan as neither of us was relieved from our post by the Government of India.

It was during this period that I decided to put down my memoirs and express my observations and opinions on certain issues.

The biggest problem Indian youth faced, I felt, was a lack of clarity of vision, a lack of direction. It was then that I decided to write about the circumstances and people who made me what I am today; the idea was not merely to pay tribute to some individuals or highlight certain aspects of my life. What I wanted to say was that no one, however poor, underprivileged or small, need feel disheartened about life. Problems are a part of life. Suffering is the essence of success. As someone said:

God has not promised
Skies always blue,
Flower-strewn pathways
All our life through;
God has not promised
Sun without rain,
Joy without sorrow,
Peace without pain.

I will not be presumptuous enough to say that my life can be a role model for anybody; but some poor child living in an obscure place, in an underprivileged social setting may find a little solace in the way my destiny has been shaped. It could perhaps help such children liberate themselves from the bondage of their illusory backwardness and hopelessness. Irrespective of where they are right now, they should be aware that God is with them and when He is with them, who can be against them?

But God has promised
Strength for the day,
Rest for the labour
Light for the way.

It has been my observation that most Indians suffer unnecessary misery all their lives because they do not know how to manage their emotions. They are paralysed by some sort of a psychological inertia. Phrases like 'the next best alternative', 'the only feasible option or solution', and 'till things take a turn for the better' are commonplace in our business conversations. Why not write about the deep-rooted character traits which manifest themselves in such widespread, self-defeatist thought patterns and negative behaviour? I have worked with many people and organizations and have had to deal with people who were so full of their own limitations that they had no other way to prove their self-worth than by intimidating me. Why not write about the victimization which is a hallmark of the tragedy of Indian science and technology? And about the pathways to organizational success? Let the latent fire in the heart of every Indian acquire wings, and the glory of this great country light up the sky.

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