IV

CONTEMPLATION

[1991 –]

We create and destroy
And again recreate
In forms of which no one knows.

AL-WAQUIAH
Qur'an 56:61

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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:

Impossible 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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Leaders

Technology, unlike science, is a group activity. It is not based on individual intelligence, but on the interaction of many people. I think the biggest success of IGMDP is not the fact that in record time the country acquired the capability of making five state-of-the-art missile systems but that through it, some superb teams of scientists and engineers have been created. If someone asks me about my personal achievements in Indian rocketry, I would put it down to having created a challenging environment for teams of young people to work in.

In their formative stages, teams are much like children in spirit. They are as excitable, as full of vitality, enthusiasm, curiosity and the desire to please and excel. As with children, however, these positive attributes can be destroyed by the behaviour of misguided parents. For teams to be successful, the environment must offer scope for innovation. I confronted many such challenges during the course of my work at DTD&P (Air), ISRO, DRDO and elsewhere, but always ensured for my teams an environment which allowed innovation and risk-taking.

When we first began creating project teams during the SLV-3 project and later in IGMDP, people working in these teams found themselves in the frontline of their organizations' ambitions. Since a great deal of psychological investment had been made in these teams, they became both highly visible and highly vulnerable. They were personally expected to make a disproportionate contribution to win collective glory.

I was aware that any failure in the organizational support system would negate the investment in team strategies. The teams would be relegated to the league of average working groups and might fail even there, unable to meet the high expectations set for them. On several occasions, the organization was on the verge of losing its nerve and imposing restraints. The high level of uncertainty and complexity associated with team activity very often proves to be a trap for the unwary.

In the early years of the SLV-3 project, I often had to counter nervousness of the top people because progress was not tangibly or immediately visible. Many felt that the organization had lost control over SLV-3, that the team would run on unchecked, and cause chaos and confusion. But on all occasions, these fears were proved imaginary. There were many people in powerful positions in organizations, for example at VSSC, who underestimated our responsibility and commitment to organizational objectives. Dealing with such people was a crucial part of the whole operation, and this was performed dexterously by Dr Brahm Prakash.

When you work as a project team, you need to develop a complex view of the success criteria. There are always multiple and often conflicting sets of expectations that exist about a team's performance. Then, quite often, the project teams are virtually torn apart in their attempt to accommodate the needs and constraints of sub-contractors outside the organization and specialist departments within the organization. Good project teams are able to quickly identify the key person or people with whom negotiations must take place. A crucial aspect of the team leader's role is to negotiate with these key people for their requirements, and to ensure that the dialogue continues on a regular basis as the situation develops or changes. If there is one thing outsiders dislike, it is unpleasant surprises. Good teams ensure that there are none.

The SLV-3 team developed their own internal success criteria. We articulated our standards, expectations and objectives. We summarised what was needed to happen for us to be successful and how we would measure success. For instance, how we were going to accomplish our tasks, who would do what and according to what standards, what were the time limits and how would the team conduct itself with reference to others in the organization.

The process of arriving at the success criteria within a team is an intricate and skilled one because there are a lot of things going on below the surface. On the surface, the team is simply working to achieve the project's goals. But I have repeatedly seen how people are poor at articulating what they want—until they see a work centre doing something they don't want them to do. A project team member must in fact act like a detective. He should probe for clues as to how the project is proceeding, and then piece together different bits of evidence to build up a clear, comprehensive and deep understanding of the project's requirements.

At another level, the relationship between the project teams and the work centres should be encouraged and developed by the project leader. Both parties must be very clear in their minds about their mutual interdependence and the fact that both of them have a stake in the project. At yet another level, each side should assess the other's capabilities and identify areas of strength and weakness in order to plan what needs doing and how it should be done. In fact, the whole game can be seen as a process of contracting. It is about exploring and arriving at an agreement on what each party expects of the other; about realistically understanding the constraints of the other party; and about communicating the success criteria while defining some simple rules about how the relationship is to work; but above all, it's the best means of developing clarity in the relationship, both at the technical and personal levels, in order to avoid any nasty surprises in the future. In IGMDP, Sivathanu Pillai and his team did some remarkable work in this area through their home-grown technique, PACE, which stands for Programme Analysis, Control and Evaluation. Each day between 12 noon and 1 p.m., they would sit with a project team and a particular work centre that was on the critical path and assess the level of success among themselves. The excitement of planning ways to succeed and the vision of future success provide an irresistible form of motivation which, I have found, always makes things happen.

The concept of Technology Management has its roots in the Developmental Management models which originated in the early Sixties out of a conflict between harmony-seeking and output-oriented management structures. There are basically two types of management orientations: primal, which values an economic employee, and rational,

which values an organizational employee. My concept of management is woven around an employee who is a technology person. While the primal management school recognizes people for their independence, and rational management acknowledges them for their dependability, I value them for their interdependence. Whereas the primal manager champions independent enterprise and the rational manager serves cooperation, I moot interdependent joint ventures, getting the forces together, networking people, resources, time schedules, costs, and so on.

Abraham Maslow was the first person to suggest the new psychology of self-actualization at a conceptual level. In Europe, Rudolf Steiner and Reg Revans developed this concept into the system of individual learning and organizational renewal. The Anglo-German management philosopher, Fritz Schumacher introduced Buddhist economics and authored the concept of "Small is Beautiful". In the Indian subcontinent, Mahatma Gandhi emphasized grass root level technology and put the customer at the centre of the entire business activity. JRD Tata brought in progress-driven infrastructure. Dr Homi Jehangir Bhabha and Prof. Vikram Sarabhai launched the high, technology-based atomic energy and space programmes with a clear-cut emphasis on the natural laws of totality and flow. Advancing the developmental philosophy of Dr Bhabha and Prof. Sarabhai, Dr MS Swaminathan ushered the Green Revolution into India working on another natural principle of integrity. Dr Verghese Kurien brought in a powerful cooperative movement through a revolution in the dairy industry. Prof. Satish Dhawan developed mission management concepts in space research. These are but a few examples of individuals who have not only articulated but also implemented their ideas, thus changing forever the face of research and business organizations all over the world.

In the IGMDP, I attempted to integrate the vision of Prof. Sarabhai and the mission of Prof. Dhawan by adapting the high technology setting of Dr Brahm Prakash's space research. I attempted to add the natural law of Latency in founding the Indian Guided Missile Programme in order to create a completely indigenous variety of technology management. Let me use a metaphor to illuminate this.

The tree of technology management takes root only if there is the self-actualization of needs, renewal, interdependence, and natural flow. The growth patterns are characteristic of the evolution process, which means that things move in a combination of slow change and sudden transformation; each transformation causes either a leap into a new, more complex level or a devastating crash to some earlier level; dominant models reach a certain peak of success when they turn troublesome; and the rate of change always accelerates.

The stem of the tree is the molecular structure in which all actions are formative, all policies are normative, and all decisions are integrative. The branches of this tree are resources, assets, operations, and products which are nourished by the stem through a continuous performance evaluation and corrective update.

This tree of technology management, if carefully tended, bears the fruits of an adaptive infrastructure: technological empowerment of the institutions, the generation of technical skills among people, and finally self-reliance of the nation and improvement in the quality of life of its citizenry.

When IGMDP was sanctioned in 1983, we did not have an adequate technology base. A few pockets of expertise were available, but we lacked the authority to utilize that expert technology. The multi-project environment of the programme provided a challenge, for five advanced missile systems had to be simultaneously developed. This demanded judicious sharing of resources, establishing priorities, and ongoing induction of manpower. Eventually, the IGMDP had 78 partners, including 36 technology centres and 41 production centres spread over public sector undertakings, ordnance factories, private industries, and professional societies, hand-in hand with a well-knit bureaucratic structure in the Government. In the management of the Programme, as much as in the technological inputs, we attempted to develop a model that was appropriate, even tailor-made, for our very specific needs and capabilities. We borrowed ideas that had been developed elsewhere, but adapted them in the light of what we knew were our strengths and what we recognized as the constraints we would be compelled to work under. All in all, the combination of appropriate management and our cooperative endeavours helped to unearth the talent and potential that lay unused in

our research laboratories, government institutions and private industries.

The Technology Management philosophy of IGMDP is not exclusive to missile development. It represents the national urge to succeed and an awareness that the world will never again be directed by muscle or money power. In fact, both these powers will depend on technological excellence. Technology respects only technology. And, as I said in the beginning, technology, unlike science, is a group activity. It does not grow only through individual intelligence, but by intelligences interacting and ceaselessly influencing one another. And that is what I tried to make IGMDP: a 78-strong Indian family which also makes missile systems.

There has been much speculation and philosophizing about the life and times of our scientists, but not enough exploration in determining where they wanted to go and how they reached there. In sharing with you the story of my struggle to become a person, I have perhaps given you some insight into this journey. I hope it will help at least a few young people to stand up to the authoritarianism in our society. A characteristic feature of this social authoritarianism is its insidious ability to addict people to the endless pursuit of external rewards, wealth, prestige, position, promotion, approval of one's lifestyle by others, ceremonial honours, and status symbols of all kinds.

To successfully pursue these goals, they have to learn elaborate rules of etiquette and familiarize themselves with customs, traditions, protocols and so on. The youth of today must unlearn this self-defeating way of life. The culture of working only for material possessions and rewards must be discarded. When I see wealthy, powerful and learned people struggling to be at peace with themselves, I remember people like Ahmed Jallaluddin and Iyadurai Solomon. How happy they were with virtually no possessions!

On the coast of Coromandel
Where the earthy shells blow,
In the middle of the sands
Lived some really rich souls.
One cotton lungi and half a candle –
One old jug without a handle
These were all the worldly possessions
Of these kings in the middle of the sands.

How did they feel so secure without anything to fall back upon? I believe they drew sustenance from within. They relied more on the inner signals and less on the external cues that I have mentioned above. Are you aware of your inner signals? Do you trust them? Have you taken control over your life into your own hands? Take this from me, the more decisions you can make avoiding external pressures, which will constantly try to manipulate you, the better your life will be, the better your society will become. Infact the entire nation will benefit by having strong, inward-looking people as their leaders. A citizenry that thinks for itself, a country of people who trust themselves as individuals, would be virtually immune to manipulation by any unscrupulous authority or vested interest.

Your willingness to use your own inner resources to invest in your life, especially your imagination, will bring you success. When you address a task from your own uniquely individual standpoint, you become a whole person.

Everyone on this planet is sent forth by Him to cultivate all the creative potential within us and live at peace with our own choices. We differ in the way we make our choices and evolve our destiny. Life is a difficult game. You can win only by retaining your birthright to be a person. And to retain this right, you will have to be willing to take the social or external risks involved in ignoring pressures to do things the way others say they should be done. What will you call Sivasubramania Iyer inviting me to have lunch in his kitchen? Zohara, my sister, mortgaging her gold bangles and chains to get me into engineering college? Prof. Sponder insisting that I should sit with him in the front row for the group photograph? Making a hovercraft in a motor-garage setup? Sudhakar's courage? Dr Brahm Prakash's support? Narayanan's management? Venkataraman's vision? Arunachalam's drive? Each is an example of a strong inner strength and initiative. As Pythagoras had said twenty-five centuries ago, "Above all things, reverence yourself."

I am not a philosopher. I am only a man of technology. I spent all my life learning rocketry. But as I have worked with a very large cross-section of people in different organizations, I had an opportunity to understand the phenomenon of professional life in its bewildering

complexity. When I look back upon what I have narrated so far, my own observations and conclusions appear as dogmatic utterances. My colleagues, associates, leaders; the complex science of rocketry; the important issues of technology management; all seem to have been dealt with in a perfunctory manner. The despair and happiness, the achievements and the failures—differing markedly in context, time, and space—all appear grouped together.

When you look down from an aircraft, people, houses, rocks, fields, trees, all appear as one homogeneous landscape, it is very difficult to distinguish one from another. What you have just read is a similar bird's-eye view of my life seen, as it were, from afar.

My worthiness is all my doubt –
His merit – all my fear –
Contrasting which my quality
Does however – appear.

This is the story of the period ending with the first Agni launch—life will go on. This great country will make enormous strides in all fields if we think like a united nation of 900 million people. My story—the story of the son of Jainulabdeen, who lived for over a hundred years on Mosque Street in Rameswaram island and died there; the story of a lad who sold newspapers to help his brother; the story of a pupil reared by Sivasubramania Iyer and Iyadurai Solomon; the story of a student taught by teachers like Pandalai; the story of an engineer spotted by MGK Menon and groomed by the legendary Prof. Sarabhai; the story of a scientist tested by failures and setbacks; the story of a leader supported by a large team of brilliant and dedicated professionals. This story will end with me, for I have no belongings in the worldly sense. I have acquired nothing, built nothing, possess nothing—no family, sons, daughters.

I am a well in this great land
Looking at its millions of boys and girls
To draw from me
The inexhaustible divinity
And spread His grace everywhere
As does the water drawn from a well.

I do not wish to set myself up as an example to others, but I believe that a few readers may draw inspiration and come to experience that ultimate satisfaction which can only be found in the life of the spirit. God's providence is your inheritance. The bloodline of my great-grandfather Avul, my grandfather Pakir, and my father Jainulabdeen may end with Abdul Kalam, but His grace will never cease, for it is Eternal.

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Epilogue

This book is interwoven with my deep involvement with India's first Satellite Launch Vehicle SLV-3 and Agni Programmes, an involvement which eventually led to my participation in the recent important national event related to the nuclear tests in May, 1998. I have had the great opportunity and honour of working with three scientific establishments—Space, Defence Research and Atomic Energy. I found, while working in these establishments, that the best of human beings and the best of innovative minds were available in plenty. One feature common to all three establishments, is that the scientists and technologists were never afraid of failures during their missions. Failures contain within themselves the seeds of further learning which can lead to better technology, and eventually, to a high level of success. These people were also great dreamers and their dreams finally culminated in spectacular achievements. I feel that if we consider the combined technological strength of all these scientific institutions, it would certainly be comparable to the best found anywhere in the world. Above all, I have had the opportunity of working with the great visionaries of the nation, namely Prof. Vikram Sarabhai, Prof. Satish Dhawan and Dr Brahm Prakash, each of whom have greatly enriched my life.

A nation needs both economic prosperity and strong security for growth and development. Our Self Reliance Mission in Defence System 1995–2005 will provide the Armed Forces with a state-of-the-art competitive weapons system. The Technology Vision – 2020 plan will put into place certain schemes and plans for the economic growth and prosperity of the nation. These two plans have evolved out of the nation's dreams. I earnestly hope and pray that the development resulting from these two plans—Self Reliance Mission and Technology Vision – 2020—will eventually make our country strong and prosperous and take our rightful place among the ranks of the "developed" nations.

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