I

ORIENTATION

[1931 – 1963]

This earth is His, to Him belong those vast and boundless skies;Both seas within Him rest, and yet in that small pool He lies.

ATHARVA VEDA
Book 4, Hymn 16.

1

I was born into a middle-class Tamil family in the island town of Rameswaram in the erstwhile Madras state. My father, Jainulabdeen, had neither much formal education nor much wealth; despite these disadvantages, he possessed great innate wisdom and a true generosity of spirit. He had an ideal helpmate in my mother, Ashiamma. I do not recall the exact number of people she fed every day, but I am quite certain that far more outsiders ate with us than all the members of our own family put together.

My parents were widely regarded as an ideal couple. My mother's lineage was the more distinguished, one of her forebears having been bestowed the title of 'Bahadur' by the British.

I was one of many children—a short boy with rather undistinguished looks, born to tall and handsome parents. We lived in our ancestral house, which was built in the middle of the 19th century. It was a fairly large pucca house, made of limestone and brick, on the Mosque Street in Rameswaram. My austere father used to avoid all inessential comforts and luxuries. However, all necessities were provided for, in terms of food, medicine or clothes. In fact, I would say mine was a very secure childhood, both materially and emotionally.

I normally ate with my mother, sitting on the floor of the kitchen. She would place a banana leaf before me, on which she then ladled rice and aromatic sambhar, a variety of sharp, home-made pickles and a dollop of fresh coconut chutney.

The famous Shiva temple, which made Rameswaram so sacred to pilgrims, was about a ten-minute walk from our house. Our locality was predominantly Muslim, but there were quite a few Hindu families too, living amicably with their Muslim neighbours. There was a very old mosque in our locality where my father would take me for evening prayers. I had not the faintest idea of the meaning of the Arabic prayers chanted, but I was totally convinced that they reached God. When my father came out of the mosque after the prayers, people of different religions would be sitting outside, waiting for him. Many of them offered bowls of water to my father who would dip his fingertips in them and say a prayer. This water was then carried home for invalids. I also remember people visiting our home to offer thanks after being cured. My father always smiled and asked them to thank Allah, the benevolent and merciful.

The high priest of Rameswaram temple, Pakshi Lakshmana Sastry, was a very close friend of my father's. One of the most vivid memories of my early childhood is of the two men, each in his traditional attire, discussing spiritual matters. When I was old enough to ask questions, I asked my father about the relevance of prayer. My father told me there was nothing mysterious about prayer. Rather, prayer made possible a communion of the spirit between people. "When you pray," he said, "you transcend your body and become a part of the cosmos, which knows no division of wealth, age, caste, or creed."

My father could convey complex spiritual concepts in very simple, down-to-earth Tamil. He once told me, "In his own time, in his own place, in what he really is, and in the stage he has reached—good or bad—every human being is a specific element within the whole of the manifest divine Being. So why be afraid of difficulties, sufferings and problems? When troubles come, try to understand the relevance of your sufferings. Adversity always presents opportunities for introspection."

"Why don't you say this to the people who come to you for help and advice?" I asked my father. He put his hands on my shoulders and looked straight into my eyes. For quite some time he said nothing, as if he was judging my capacity to comprehend his words. Then he answered in a low, deep voice. His answer filled me with a strange energy and enthusiasm:

Whenever human beings find themselves alone, as a natural reaction, they start looking for company. Whenever they are in trouble, they look for someone to help them. Whenever they reach an impasse, they look to someone to show them the way out. Every recurrent anguish, longing, and desire finds its own special helper. For the people who come to me in distress, I am but a go-between in their effort to propitiate demonic forces with prayers and offerings. This is not a correct approach at all and should never be followed. One must understand the difference between a fear-ridden vision of destiny and the vision that enables us to seek the enemy of fulfilment within ourselves.

I remember my father starting his day at 4 a.m. by reading the namaz before dawn. After the namaz, he used to walk down to a small coconut grove we owned, about 4 miles from our home. He would return, with about a dozen coconuts tied together thrown over his shoulder, and only then would he have his breakfast. This remained his routine even when he was in his late sixties.

I have throughout my life tried to emulate my father in my own world of science and technology. I have endeavoured to understand the fundamental truths revealed to me by my father, and feel convinced that there exists a divine power that can lift one up from confusion, misery, melancholy and failure, and guide one to one's true place. And once an individual severs his emotional and physical bondage, he is on the road to freedom, happiness and peace of mind.

I was about six years old when my father embarked on the project of building a wooden sailboat to take pilgrims from Rameswaram to Dhanuskodi, (also called Sethukkarai), and back. He worked at building the boat on the seashore, with the help of a relative, Ahmed Jallaluddin, who later married my sister, Zohara. I watched the boat take shape. The wooden hull and bulkheads were seasoned with the heat from wood fires. My father was doing good business with the boat when, one day, a cyclone bringing winds of over 100 miles per hour carried away our boat, along with some of the landmass of Sethukkarai. The Pamban Bridge collapsed with a train full of passengers on it. Until then, I had only seen the beauty of the sea, now its uncontrollable energy came as a revelation to me.

By the time the boat met its untimely end, Ahmed Jallaluddin had become a close friend of mine, despite the difference in our ages. He was about 15 years older than I and used to call me Azad. We used to go for long walks together every evening. As we started from Mosque Street and made our way towards the sandy shores of the island, Jallaluddin and I talked mainly of spiritual matters. The atmosphere of Rameswaram, with its flocking pilgrims, was conducive to such discussion. Our first halt would be at the imposing temple of Lord Shiva. Circling around the temple with the same reverence as any pilgrim from a distant part of the country, we felt a flow of energy pass through us.

Jallaluddin would talk about God as if he had a working partnership with Him. He would present all his doubts to God as if He were standing nearby to dispose of them. I would stare at Jallaluddin and then look towards the large groups of pilgrims around the temple, taking holy dips in the sea, performing rituals and reciting prayers with a sense of respect towards the same Unknown, whom we treat as the formless Almighty. I never doubted that the prayers in the temple reached the same destination as the ones offered in our mosque. I only wondered whether Jallaluddin had any other special connection to God. Jallaluddin's schooling had been limited, principally because of his family's straitened circumstances. This may have been the reason why he always encouraged me to excel in my studies and enjoyed my success vicariously. Never did I find the slightest trace of resentment in Jallaluddin for his deprivation. Rather, he was always full of gratitude for whatever life had chosen to give him.

Incidentally, at the time I speak of, he was the only person on the entire island who could write English. He wrote letters for almost anybody in need, be they letters of application or otherwise. Nobody of my acquaintance, either in my family or in the neighbourhood even had Jallaluddin's level of education or any links of consequence with the outside world. Jallaluddin always spoke to me about educated people, of scientific discoveries, of contemporary literature, and of the achievements of medical science. It was he who made me aware of a "brave, new world" beyond our narrow confines.

In the humble environs of my boyhood, books were a scarce commodity. By local standards, however, the personal library of STR Manickam, a former 'revolutionary' or militant nationalist, was sizeable. He encouraged me to read all I could and I often visited his home to borrow books.

Another person who greatly influenced my boyhood was my first cousin, Samsuddin. He was the sole distributor for newspapers in Rameswaram. The newspapers would arrive at Rameswaram station by the morning train from Pamban. Samsuddin's newspaper agency was a one-man organization catering to the reading demands of the 1,000-strong literate population of Rameswaram town. These newspapers were mainly bought to keep abreast of current developments in the National Independence Movement, for astrological reference or to check the bullion rates prevailing in Madras. A few readers with a more cosmopolitan outlook would discuss Hitler, Mahatma Gandhi and Jinnah; almost all would finally flow into the mighty political current of Periyar EV Ramaswamy's movement against high caste Hindus. Dinamani was the most sought after newspaper. Since reading the printed matter was beyond my capability, I had to satisfy myself with glancing at the pictures in the newspaper before Samsuddin delivered them to his customers.

The Second World War broke out in 1939, when I was eight years old. For reasons I have never been able to understand, a sudden demand for tamarind seeds erupted in the market. I used to collect the seeds and sell them to a provision shop on Mosque Street. A day's collection would fetch me the princely sum of one anna. Jallaluddin would tell me stories about the war which I would later attempt to trace in the headlines in Dinamani. Our area, being isolated, was completely unaffected by the war. But soon India was forced to join the Allied Forces and something like a state of emergency was declared. The first casualty came in the form of the suspension of the train halt at Rameswaram station. The newspapers now had to be bundled and thrown out from the moving train on the Rameswaram Road between Rameswaram and Dhanuskodi. That forced Samsuddin to look for a helping hand to catch the bundles and, as if naturally, I filled the slot. Samsuddin helped me earn my first wages. Half a century later, I can still feel the surge of pride in earning my own money for the first time.

Every child is born, with some inherited characteristics, into a specific socio-economic and emotional environment, and trained in certain ways by figures of authority. I inherited honesty and self-discipline from my father; from my mother, I inherited faith in goodness and deep kindness and so did my three brothers and sister. But it was the time I spent with Jallaluddin and Samsuddin that perhaps contributed most to the uniqueness of my childhood and made all the difference in my later life. The unschooled wisdom of Jallaluddin and Samsuddin was so intuitive and responsive to non-verbal messages, that I can unhesitatingly attribute my subsequently manifested creativity to their company in my childhood.

I had three close friends in my childhood—Ramanadha Sastry, Aravindan, and Sivaprakasan. All these boys were from orthodox Hindu Brahmin families. As children, none of us ever felt any difference amongst ourselves because of our religious differences and upbringing. In fact, Ramanadha Sastry was the son of Pakshi Lakshmana Sastry, the high priest of the Rameswaram temple. Later, he took over the priesthood of the Rameswaram temple from his father; Aravindan went into the business of arranging transport for visiting pilgrims; and Sivaprakasan became a catering contractor for the Southern Railways.

During the annual Shri Sita Rama Kalyanam ceremony, our family used to arrange boats with a special platform for carrying idols of the Lord from the temple to the marriage site, situated in the middle of the pond called Rama Tirtha which was near our house. Events from the Ramayana and from the life of the Prophet were the bedtime stories my mother and grandmother would tell the children in our family.

One day when I was in the fifth standard at the Rameswaram Elementary School, a new teacher came to our class. I used to wear a cap which marked me as a Muslim, and I always sat in the front row next to Ramanadha Sastry, who wore a sacred thread. The new teacher could not stomach a Hindu priest's son sitting with a Muslim boy. In accordance with our social ranking as the new teacher saw it, I was asked to go and sit on the back bench. I felt very sad, and so did

Ramanadha Sastry. He looked utterly downcast as I shifted to my seat in the last row. The image of him weeping when I shifted to the last row left a lasting impression on me.

After school, we went home and told our respective parents about the incident. Lakshmana Sastry summoned the teacher, and in our presence, told the teacher that he should not spread the poison of social inequality and communal intolerance in the minds of innocent children. He bluntly asked the teacher to either apologize or quit the school and the island. Not only did the teacher regret his behaviour, but the strong sense of conviction Lakshmana Sastry conveyed ultimately reformed this young teacher.

On the whole, the small society of Rameswaram was highly stratified and very rigid in terms of the segregation of different social groups. However, my science teacher Sivasubramania Iyer, though an orthodox Brahmin with a very conservative wife, was something of a rebel. He did his best to break social barriers so that people from varying backgrounds could mingle easily. He used to spend hours with me and would say, "Kalam, I want you to develop so that you are on par with the highly educated people of the big cities."

One day, he invited me to his home for a meal. His wife was horrified at the idea of a Muslim boy being invited to dine in her ritually pure kitchen. She refused to serve me in her kitchen. Sivasubramania Iyer was not perturbed, nor did he get angry with his wife, but instead, served me with his own hands and sat down beside me to eat his meal. His wife watched us from behind the kitchen door. I wondered whether she had observed any difference in the way I ate rice, drank water or cleaned the floor after the meal. When I was leaving his house, Sivasubramania Iyer invited me to join him for dinner again the next weekend. Observing my hesitation, he told me not to get upset, saying, "Once you decide to change the system, such problems have to be confronted." When I visited his house the next week, Sivasubramania Iyer's wife took me inside her kitchen and served me food with her own hands.

Then the Second World War was over and India's freedom was imminent. "Indians will build their own India," declared Gandhiji. The whole country was filled with an unprecedented optimism. I asked my father's permission to leave Rameswaram and study at the district headquarters in Ramanathapuram.

He told me as if thinking aloud, "Abul! I know you have to go away to grow. Does the seagull not fly across the Sun, alone and without a nest? You must forego your longing for the land of your memories to move into the dwelling place of your greater desires; our love will not bind you nor will our needs hold you." He quoted Khalil Gibran to my hesitant mother, "Your children are not your children. They are the sons and daughters of Life's longing for itself. They come through you but not from you. You may give them your love but not your thoughts. For they have their own thoughts."

He took me and my three brothers to the mosque and recited the prayer Al Fatiha from the Holy Qur'an. As he put me on the train at Rameswaram station he said, "This island may be housing your body but not your soul. Your soul dwells in the house of tomorrow which none of us at Rameswaram can visit, not even in our dreams. May God bless you, my child!"

Samsuddin and Ahmed Jallaluddin travelled with me to Ramanathapuram to enrol me in Schwartz High School, and to arrange for my boarding there. Somehow, I did not take to the new setting. The town of Ramanathapuram was a thriving, factious town of some fifty thousand people, but the coherence and harmony of Rameswaram was absent. I missed my home and grabbed every opportunity to visit Rameswaram. The pull of educational opportunities at Ramanathapuram was not strong enough to nullify the attraction of poli, a South Indian sweet my mother made. In fact, she used to prepare twelve distinctly different varieties of it, bringing out the flavour of every single ingredient used in the best possible combinations.

Despite my homesickness, I was determined to come to terms with the new environment because I knew my father had invested great hopes in my success. My father visualized me as a Collector in the making and I thought it my duty to realise my father's dream, although I desperately missed the familiarity, security and comforts of Rameswaram.

Jallaluddin used to speak to me about the power of positive thinking and I often recalled his words when I felt homesick or dejected. I tried hard to do as he said, which was to strive to control my thoughts and my mind and, through these, to influence my destiny. Ironically, that destiny did not lead me back to Rameswaram, but rather, swept me farther away from the home of my childhood.

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2

Once I settled down at the Schwartz High School, Ramanathapuram, the enthusiastic fifteen-year-old within me re-emerged. My teacher, Iyadurai Solomon, was an ideal guide for an eager young mind that was yet uncertain of the possibilities and alternatives that lay before it. He made his students feel very comfortable in class with his warm and open-minded attitude. He used to say that a good student could learn more from a bad teacher than a poor student from even a skilled teacher.

During my stay at Ramanathapuram, my relationship with him grew beyond that of teacher and pupil. In his company, I learnt that one could exercise enormous influence over the events of one's own life. Iyadurai Solomon used to say, "To succeed in life and achieve results, you must understand and master three mighty forces— desire, belief, and expectation." Iyadurai Solomon, who later became a Reverend, taught me that before anything I wanted could happen, I had to desire it intensely and be absolutely certain it would happen. To take an example from my own life, I had been fascinated by the mysteries of the sky and the flight of birds from early childhood. I used to watch cranes and seagulls soar into flight and longed to fly. Simple, provincial boy though I was, I was convinced that one day I, too, would soar up into the skies. Indeed, I was the first child from Rameswaram to fly.

Iyadurai Solomon was a great teacher because he instilled in all the children a sense of their own worth. Solomon raised my self-esteem to

a high point and convinced me, the son of parents who had not had the benefits of education, that I too could aspire to become whatever I wished. “With faith, you can change your destiny,” he would say.

One day, when I was in the fourth form, my mathematics teacher, Ramakrishna Iyer, was teaching another class. Inadvertently, I wandered into that classroom and in the manner of an old-fashioned despot, Ramakrishna Iyer caught me by the neck and caned me in front of the whole class. Many months later, when I scored full marks in mathematics, he narrated the incident to the entire school at morning assembly. “Whomsoever I cane becomes a great man! Take my word, this boy is going to bring glory to his school and to his teachers.” His praise quite made up for the earlier humiliation!

By the time I completed my education at Schwartz, I was a self-confident boy determined to succeed. The decision to go in for further education was taken without a second thought. To us, in those days, the awareness of the possibilities for a professional education did not exist; higher education simply meant going to college. The nearest college was at Tiruchchirappalli, spelled Trichinopoly those days, and called Trichi for short.

In 1950, I arrived at St. Joseph’s College, Trichi, to study for the Intermediate examination. I was not a bright student in terms of examination grades but, thanks to my two buddies back in Rameswaram, I had acquired a practical bent of mind.

Whenever I returned to Rameswaram from Schwartz, my elder brother Mustafa Kamal, who ran a provision store on the railway station road, would call me in to give him a little help and then vanish for hours together leaving the shop in my charge. I sold oil, onions, rice and everything else. The fastest moving items, I found, were cigarettes and bidis. I used to wonder what made poor people smoke away their hard-earned money. When spared by Mustafa, I would be put in charge of his kiosk by my younger brother, Kasim Mohammed. There I sold novelties made of seashells.

At St. Joseph’s, I was lucky to find a teacher like the Rev. Father TN Sequeira. He taught us English and was also our hostel warden. We

were about a hundred boys living in the three-storeyed hostel building. Rev. Father used to visit each boy every night with a Bible in his hand. His energy and patience was amazing. He was a very considerate person who took care of even the most minute requirements of his students. On Deepavali, on his instructions, the Brother in charge of the hostel and the mess volunteers would visit each room and distribute good gingelly oil for the ritual bath.

I stayed on the St. Joseph’s campus for four years and shared my room with two others. One was an orthodox Iyengar from Srirangam and the other a Syrian Christian from Kerala. The three of us had a wonderful time together. When I was made secretary of the vegetarian mess during my third year in the hostel, we invited the Rector, Rev. Father Kalathil, over for lunch one Sunday. Our menu included the choicest preparations from our diverse backgrounds. The result was rather unexpected, but Rev. Father was lavish in his praise of our efforts. We enjoyed every moment with Rev. Father Kalathil, who participated in our unsophisticated conversation with childlike enthusiasm. It was a memorable event for us all.

My teachers at St. Joseph were the true followers of Kanchi Paramacharya, who evoked people to “enjoy the action of giving”. The vivid memory of our mathematics teachers, Prof. Thothathri Iyengar and Prof. Suryanarayana Sastry, walking together on the campus inspires me to this day.

When I was in the final year at St. Joseph’s, I acquired a taste for English literature. I began to read the great classics, Tolstoy, Scott and Hardy being special favourites despite their exotic settings, and then I moved on to some works in Philosophy. It was around this time that I developed a great interest in Physics.

The lessons on subatomic physics at St. Joseph’s by my physics teachers, Prof. Chinna Durai and Prof. Krishnamurthy, introduced me to the concept of the half-life period and matters related to the radioactive decay of substances. Sivasubramania Iyer, my science teacher at Rameswaram, had never taught me that most subatomic particles are unstable and that they disintegrate after a certain time into other particles. All this I was learning for the first time. But when he taught me to strive

with diligence because decay is inherent in all compounded things, was he not talking of the same thing? I wonder why some people tend to see science as something which takes man away from God. As I look at it, the path of science can always wind through the heart. For me, science has always been the path to spiritual enrichment and self-realisation.

Even the rational thought-matrices of science have been home to fairy tales. I am an avid reader of books on cosmology and enjoy reading about celestial bodies. Many friends, while asking me questions related to space flights, sometimes slip into astrology. Quite honestly, I have never really understood the reason behind the great importance attached by people to the faraway planets in our solar system. As an art, I have nothing against astrology, but if it seeks acceptance under the guise of science, I reject it. I do not know how these myths evolved about planets, star constellations, and even satellites—that they can exercise power on human beings. The highly complicated calculations manipulated around the precise movements of celestial bodies, to derive highly subjective conclusions appear illogical to me. As I see it, the Earth is the most powerful and energetic planet. As John Milton puts it so beautifully in Paradise Lost, Book VIII:

. . . What if the Sun
Be centre to the World, and other stars . . . . .
The planet earth, so steadfast though she seem,
In sensibly three different motions move?

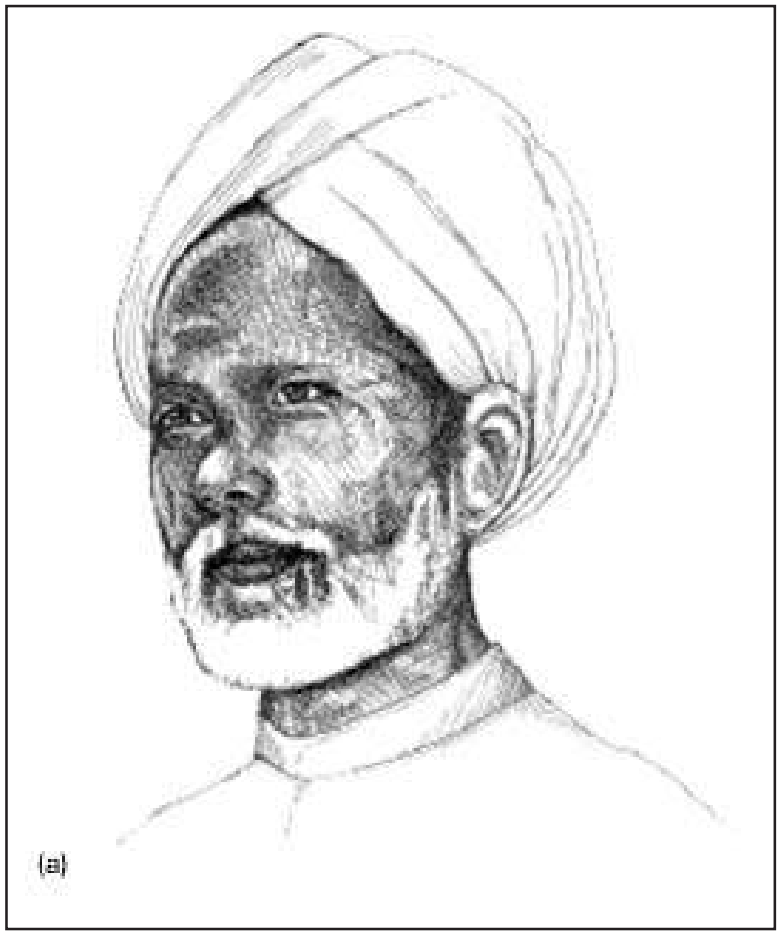
Wherever you go on this planet, there is movement and life. Even apparently inanimate things like rocks, metal, timber, clay are full of intrinsic movement—with electrons dancing around each nucleus. This motion originates in their response to the confinement imposed on them by the nucleus, by means of electric forces which try to hold them as close as possible. Electrons, just like any individual with a certain amount of energy, detest confinement. The tighter the electrons are held by the nucleus, the higher their orbital velocity will be: in fact, the confinement of electrons in an atom results in enormous velocities of about 1000 km per second! These high velocities make the atom appear a rigid sphere, just as a fast-moving fan appears like a disc. It is very difficult to compress atoms more strongly—thus giving matter its familiar solid

aspect. Everything solid, thus, contains much empty space within and everything stationary contains great movement within. It is as though the great dance of Shiva is being performed on earth during every moment of our existence.

When I joined the B.Sc. degree course at St.Joseph's, I was unaware of any other option for higher education. Nor did I have any information about career opportunities available to a student of science. Only after obtaining a B.Sc. did I realise that physics was not my subject. I had to go into engineering to realise my dreams. I could have joined the Engineering course long ago, right after finishing my Intermediate course. Better late than never, I told myself as I made the detour, applying for admission into the Madras Institute of Technology (MIT), regarded as the crown jewel of technical education in South India at that time.

I managed to be on the list of selected candidates, but admission to this prestigious institution was an expensive affair. Around a thousand rupees was required, and my father could not spare that much money. At that time, my sister, Zohara, stood behind me, mortgaging her gold bangles and chain. I was deeply touched by her determination to see me educated and by her faith in my abilities. I vowed to release her bangles from mortgage with my own earnings. The only way before me to earn money at that point of time was to study hard and get a scholarship. I went ahead at full steam.

What fascinated me most at MIT was the sight of two decommissioned aircraft displayed there for the demonstration of the various subsystems of flying machines. I felt a strange attraction towards them, and would sit near them long after other students had gone back to the hostel, admiring man's will to fly free in the sky, like a bird. After completing my first year, when I had to opt for a specific branch, I almost spontaneously chose aeronautical engineering. The goal was very clear in my mind now; I was going to fly aircraft. I was convinced of this, despite being aware of my lack of assertiveness, which probably came about because of my humble background. Around this time, I made special efforts to try and communicate with different kinds of people. There were setbacks, disappointments and distractions, but my father's inspiring words anchored me in those periods of nebulous drift.



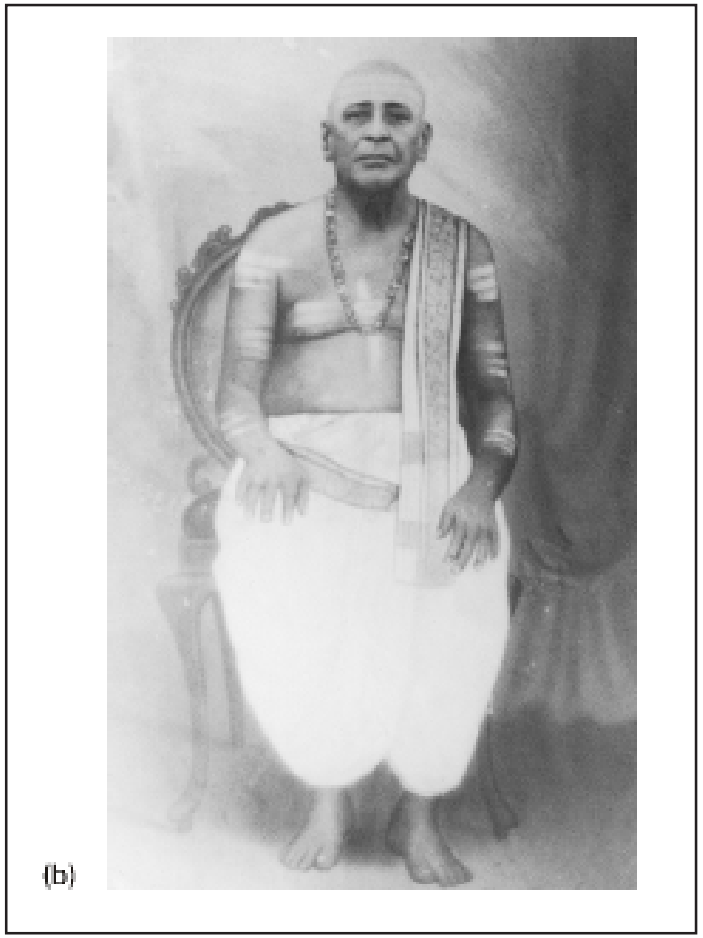


Plate 1 (a) My father Jainulabdeen was not formally educated, but was a man of great wisdom and kindness. (b) Pakshi Lakshmana Sastry, a close friend of my father and the head priest of the Rameswaram Temple.

(a)

(b)

Plate 2 The locality in which I grew up: (a) My house on Mosque Street. (b) Thousands of pilgrims from great distances descend on the ancient temple of Lord Shiva. I often assisted my brother Kasim Mohamed in his shop selling artifacts on this street.

Plate 3 The old mosque in our locality where my father would take me and my brothers every evening to offer prayers.

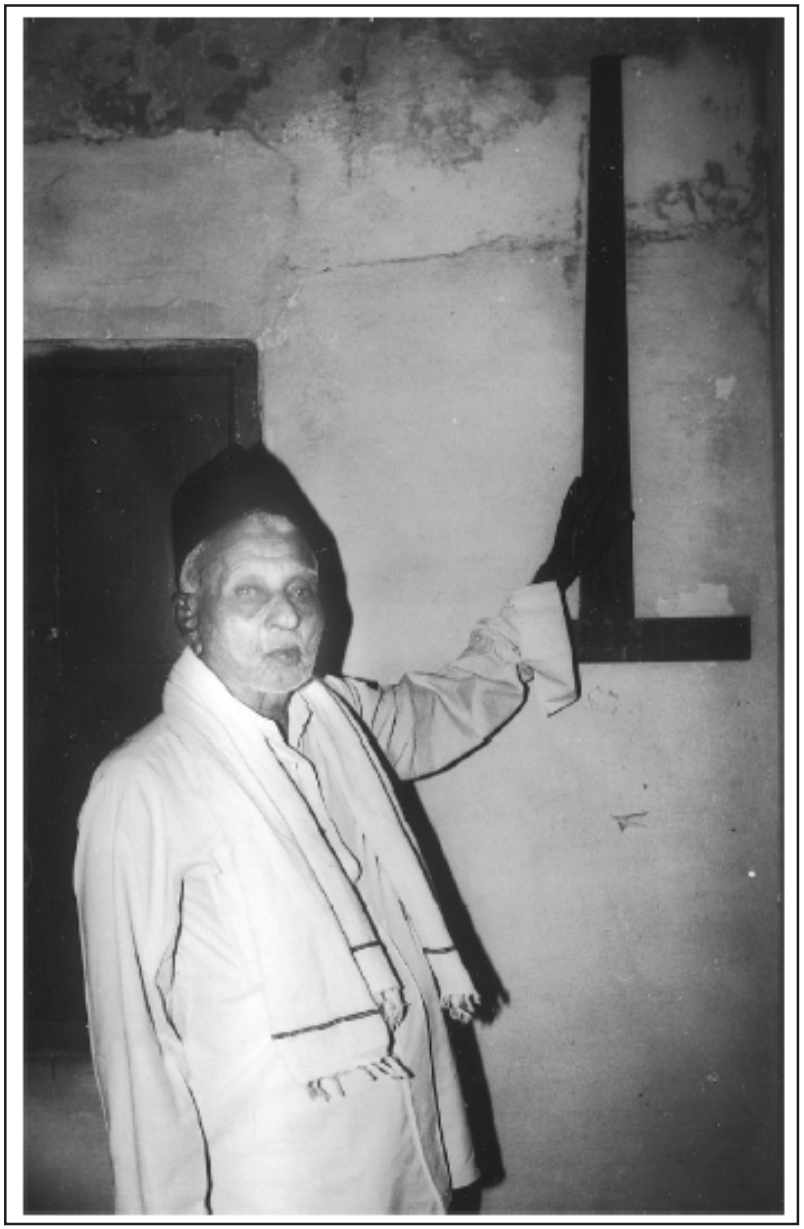


Plate 4 My brother pointing at the T–square I used while studying engineering.

Plate 5 STR Manickam (inset), a friend of my brother Mustafa Kamal, had a large collection of books. This is his house, from where I would borrow books while at Rameswaram.

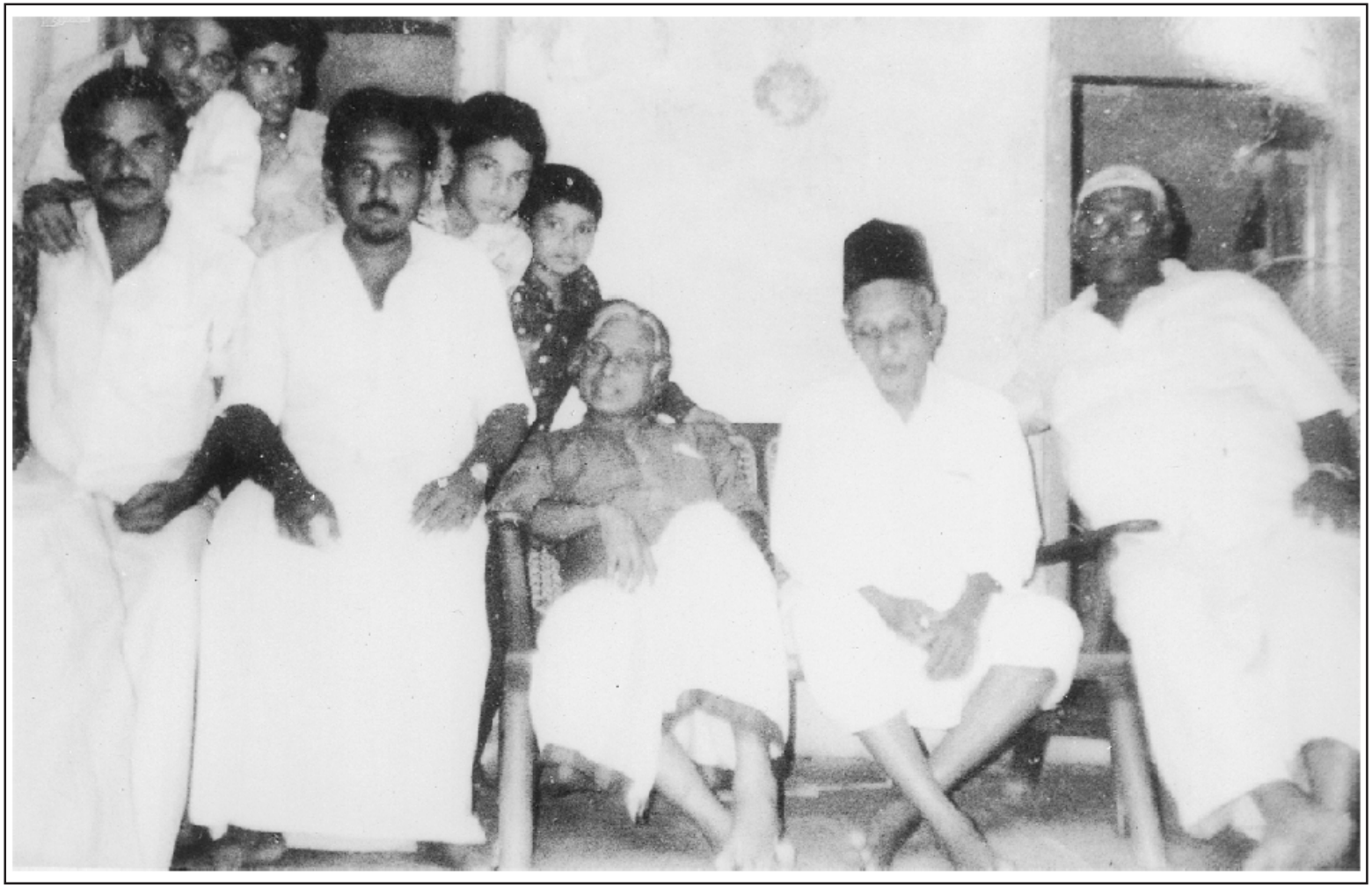


Plate 6 A family get-together.

Plate 7 The simple surroundings of Schwartz High School, Ramanathapuram. The words on the plaque read "Let not thy winged days be spent in vain. When once gone no gold can buy them back again."

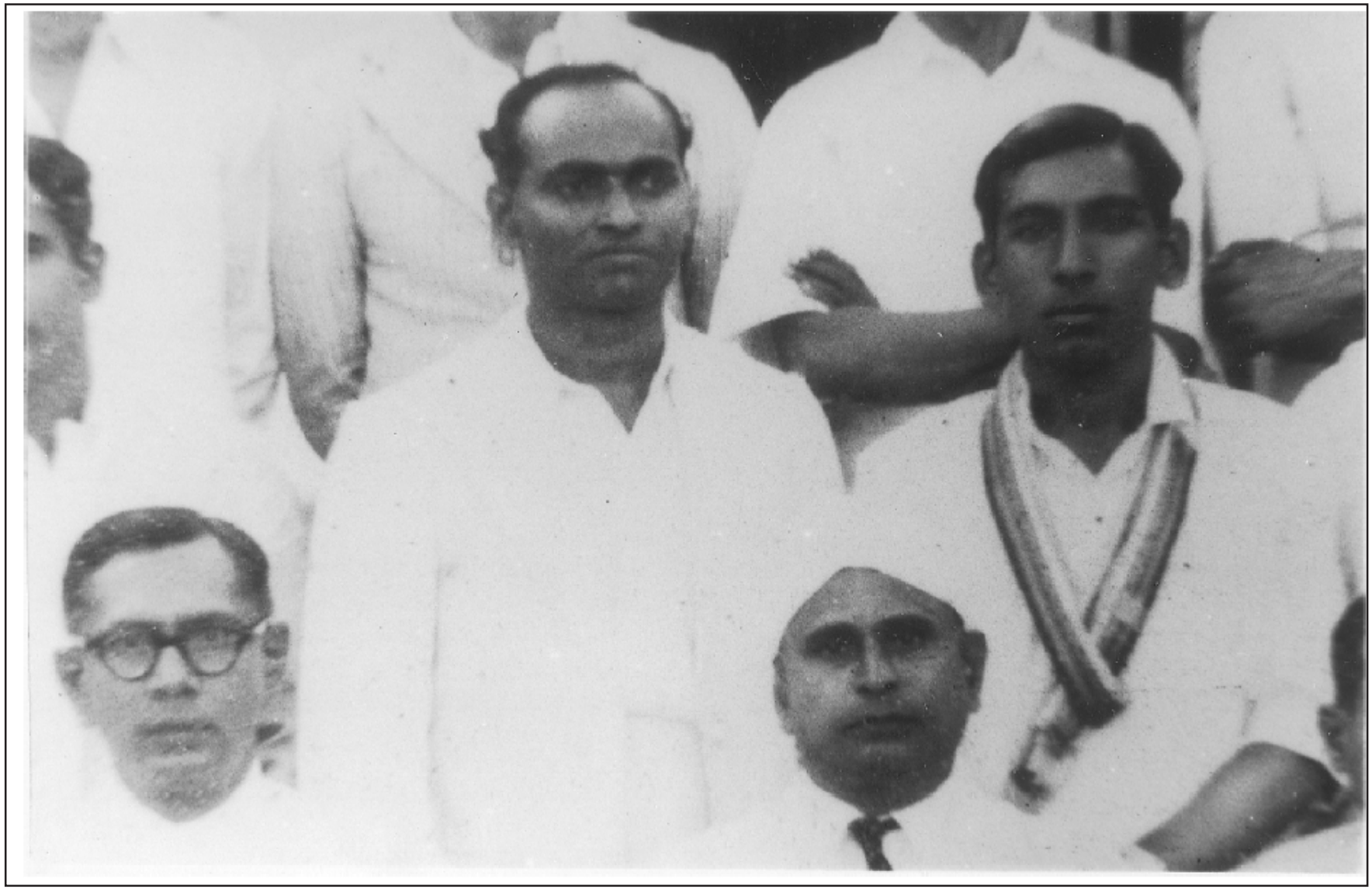


Plate 8 My teachers at Schwartz High School—Iyadurai Solomon (standing, left) and Ramakrishna Iyer (sitting, right). They are the best examples of small-town Indian teachers committed to nurturing talent.

"He who knows others is learned, but the wise one is the one who knows himself. Learning without wisdom is of no use."

In the course of my education at MIT, three teachers shaped my thinking. Their combined contributions formed the foundation on which I later built my professional career. These three teachers were Prof. Sponder, Prof. KAV Pandalai and Prof. Narasingha Rao. Each one of them had very distinct personalities, but they shared a common impulse—the capacity to feed their students' intellectual hunger by sheer brilliance and untiring zeal.

Prof. Sponder taught me technical aerodynamics. He was an Austrian with rich practical experience in aeronautical engineering. During the Second World War, he had been captured by the Nazis and imprisoned in a concentration camp. Understandably, he had developed a very strong dislike for Germans. Inciden- tally, the aeronautical department was headed by a German, Prof. Walter Repenthin. Another well-known professor, Dr Kurt Tank, was a distinguished aeronautical engineer who had designed the German Focke–Wulf FW 190 single-seater fighter plane, an outstanding combat aircraft of the Second World War. Dr Tank later joined the Hindustan Aeronautics Limited (HAL) in Bangalore and was responsible for the design of India's first jet fighter, the HF-24 Marut.

Notwithstanding these irritants, Prof. Sponder preserved his individuality and maintained high professional standards. He was always calm, energetic and in total control of himself. He kept abreast of the latest technologies and expected his students to do the same. I consulted him before opting for aeronautical engineering. He told me that one should never worry about one's future prospects: instead, it was more important to lay sound foundations, to have sufficient enthusiasm and an accompanying passion for one's chosen field of study. The trouble with Indians, Prof. Sponder used to observe, was not that they lacked educational opportunities or industrial infrastructure—the trouble was in their failure to discriminate between disciplines and to rationalise their choices. Why aeronautics? Why not electrical engineering? Why not mechanical engineering? I myself would like to tell all novitiate engineering students that when they choose their specialization, the essential point to consider is whether the choice articulates their inner feelings and aspirations.

Prof. KAV Pandalai taught me aero-structure design and analysis. He was a cheerful, friendly and enthusiastic teacher, who brought a fresh approach to every year's teaching course. It was Professor Pandalai who opened up the secrets of structural engineering to us. Even today I believe that everyone who has been taught by Prof. Pandalai would agree that he was a man of great intellectual integrity and scholarship—but with no trace of arrogance. His students were free to disagree with him on several points in the classroom.

Prof. Narasingha Rao was a mathematician, who taught us theoretical aerodynamics. I still remember his method of teaching fluid dynamics. After attending his classes, I began to prefer mathematical physics to any other subject. Often, I have been told I carry a "surgical knife" to aeronautical design reviews. If it had not been for Prof. Rao's kind and persistent advice on picking up proofs to equations of aerodynamic flow, I would not have acquired this metaphorical tool.

Aeronautics is a fascinating subject, containing within it the promise of freedom. The great difference between freedom and escape, between motion and movement, between slide and flow are the secrets of this science. My teachers revealed these truths to me. Through their meticulous teaching, they created within me an excitement about aeronautics. Their intellectual fervour, clarity of thought and passion for perfection helped me to launch into a serious study of fluid dynamics-modes of compressible medium motion, development of shock waves and shock, induced flow separation at increasing speeds, shock stall and shock-wave drag.

Slowly, a great amalgamation of information took place in my mind. The structural features of aeroplanes began to gain new meanings—biplanes, monoplanes, tailless planes, canard configured planes, delta-wing planes, all these began to assume increasing significance for me. The three teachers, all of them authorities in their different fields, helped me to mould a composite knowledge.

My third and last year at MIT was a year of transition and was to have a great impact on my later life. In those days, a new climate of political enlightenment and industrial effort was sweeping across the country. I had to test my belief in God and see if it could fit into the matrix of scientific thinking. The accepted view was that a belief in scientific methods was the only valid approach to knowledge. If so, I wondered, was matter alone the ultimate reality and were spiritual phenomena but a manifestation of matter? Were all ethical values relative, and was sensory perception the only source of knowledge and truth? I wondered about these issues, attempting to sort out the vexing question of "scientific temper" and my own spiritual interests. The value system in which I had been nurtured was profoundly religious. I had been taught that true reality lay beyond the material world in the spiritual realm, and that knowledge could be obtained only through inner experience.

Meanwhile, when I had finished my course work, I was assigned a project to design a low-level attack aircraft together with four other colleagues. I had taken up the responsibility of preparing and drawing the aerodynamic design. My team mates distributed among themselves the tasks of designing the propulsion, structure, control and instrumentation of the aircraft. One day, my design teacher, Prof. Srinivasan, then the Director of the MIT, reviewed my progress and declared it dismal and disappointing. I offered a dozen excuses for the delay, but none of them impressed Prof. Srinivasan. I finally pleaded for a month's time to complete the task. The Professor looked at me for some time and said, "Look, young man, today is Friday afternoon. I give you three days' time. If by Monday morning I don't get the configuration drawing, your scholarship will be stopped." I was dumbstruck. The scholarship was my lifeline and I would be quite helpless if it was withdrawn. I could see no other way out but to finish the task as I had been instructed. That night, I remained at the drawing board, skipping dinner. Next morning, I took only an hour's break to freshen up and eat a little food. On Sunday morning, I was very near completion, when suddenly I felt someone else's presence in the room. Prof. Srinivasan was watching me from a distance. Coming straight from the gymkhana, he was still in his tennis outfit and had dropped in to see my progress. After examining my work, Prof. Srinivasan hugged me affectionately and patted my back in appreciation. He said, "I knew I was putting you under stress and asking you to meet an impossible deadline. I never expected you to perform so well."

During the rest of the period of the project, I participated in an essay competition organized by the MIT Tamil Sangam (Literary Society). Tamil is my mother tongue and I am proud of its origins, which have been traced back to Sage Agastya in the pre-Ramayana period; its literature dates back to the fifth century BC. It is said to be a language moulded by lawyers and grammarians and is internationally acclaimed for its clear-cut logic. I was very enthusiastic about ensuring that science did not remain outside the purview of this wonderful language. I wrote an article entitled "Let Us Make Our Own Aircraft" in Tamil. The article evoked much interest and I won the competition, taking the first prize from 'Devan', the editor of the popular Tamil weekly, Ananda Vikatan.

My most touching memory of MIT is related to Prof. Sponder. We were posing for a group photograph as part of a farewell ritual. All the graduating students had lined up in three rows with the professors seated in the front. Suddenly, Prof. Sponder got up and looked for me. I was standing in the third row. "Come and sit with me in the front," he said. I was taken aback by Prof. Sponder's invitation. "You are my best student and hard work will help you bring a great name for your teachers in future." Embarrassed by the praise but honoured by the recognition, I sat with Prof. Sponder for the photograph. "Let God be your hope, your stay, your guide and provide the lantern for your feet in your journey into the future," said the introverted genius, bidding me adieu.

From MIT, I went to Hindustan Aeronautics Limited (HAL) at Bangalore as a trainee. There I worked on engine overhauling as part of a team. Hands-on work on aircraft engine overhauling was very educative. When a principle learnt in the classroom is borne out by practical experience, it creates a strange sense of excitement—akin to unexpectedly running into an old friend among a crowd of strangers. At HAL, I worked on the overhauling of both piston and turbine engines. The hazy concepts of gas dynamics and diffusion processes in the working principle of after burning came into sharper focus in my mind. I was also trained in radial engine-cum-drum operations.

I learned how to check a crankshaft for wear and tear, and a connecting rod and crankshaft for twist. I did calibrations of a fixed-pitch fan fitted to a super-charged engine. I opened up pressure and acceleration-cum-speed control systems, and air starter supply systems of turbo-engines. Getting to understand feathering, un-feathering and reversing of propeller engines was very interesting. The demonstration of the delicate art of beta (blade angle control) by HAL technicians still lingers in my memory. They had neither studied in major universities, nor were they merely implementing what their engineer-in-charge was suggesting. They had been working hands-on for years and this had given them something like an intuitive feel for the work.

Two alternative opportunities for employment, both close to my long-standing dream of flying, presented themselves before me when I came out of HAL as a graduate aeronautical engineer. One was a career in the Air Force and another was a job at the Directorate of Technical Development and Production, DTD&P(Air), at the Ministry of Defence. I applied for both. The interview calls arrived from both the places almost simultaneously. I was asked to reach Dehra Dun by the Air Force recruitment authorities and Delhi by DTD&P(Air). The boy from the Coromandel Coast took a train to the North of India. My destination was more than 2000 km away, and was to be my first encounter with the vastness of my motherland.

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Through the window of the compartment, I watched the countryside slip past. From a distance, the men in the fields in their white dhotis and turbans, and the womenfolk in bright splashes of colour against the green background of paddy fields, seemed to inhabit some beautiful painting. I sat glued to the window. Almost everywhere, people were engaged in some activity which had a rhythm and tranquillity about it—men driving cattle, women fetching water from streams. Occasionally, a child would appear and wave at the train.

It is astonishing how the landscape changes as one moves northwards. The rich and fertile plains of the river Ganga and its numerous tributaries have invited invasion, turmoil, and change. Around 1500 BC, fair-skinned Aryans swept in through the mountain passes from the far north-west. The tenth century brought Muslims, who later mingled with the local people and became an integral part of this country. One empire gave way to another. Religious conquests continued. All this time, the part of India south of the Tropic of Cancer remained largely untouched, safe behind the shield of the Vindhya and Satpura mountain ranges. The Narmada, Tapti, Mahanadi, Godavari, and Krishna rivers had woven a net of almost unassailable protection for the tapering Indian peninsula. To bring me to Delhi, my train had crossed all these geographical impediments through the power of scientific advancement.

I halted for a week in Delhi, the city of the great Sufi Saint Hazrat Nizamuddin, and appeared for the interview at DTD&P(Air). I did well at the interview. The questions were of a routine nature, and did not

challenge my knowledge of the subject. Then I proceeded to Dehra Dun for my interview at the Air Force Selection Board. At the Selection Board, the emphasis was more on "personality" than on intelligence. Perhaps they were looking for physical fitness and an articulate manner. I was excited but nervous, determined but anxious, confident but tense. I could only finish ninth in the batch of 25 examined to select eight officers for commissioning in the Air Force. I was deeply disappointed. It took me some time to comprehend that the opportunity to join the Air Force had just slipped through my fingers. I dragged myself out of the Selection Board and stood at the edge of a cliff. There was a lake far below. I knew that the days ahead would be difficult. There were questions to be answered and a plan of action to be prepared. I trekked down to Rishikesh.

I bathed in the Ganga and revelled in the purity of its water. Then, I walked to the Sivananda Ashram situated a little way up the hill. I could feel intense vibrations when I entered. I saw a large number of sadhus seated all around in a state of trance. I had read that sadhus were psychic people—people who know things intuitively and, in my dejected mood, I sought answers to the doubts that troubled me.

I met Swami Sivananda—a man who looked like a Buddha, wearing a snow-white dhoti and wooden slippers. He had an olive complexion and black, piercing eyes. I was struck by his irresistible, almost child-like smile and gracious manner. I introduced myself to the Swamiji. My Muslim name aroused no reaction in him. Before I could speak any further, he inquired about the source of my sorrow. He offered no explanation of how he knew that I was sad and I did not ask.

I told him about my unsuccessful attempt to join the Indian Air Force and my long-cherished desire to fly. He smiled, washing away all my anxiety almost instantly. Then he said in a feeble, but very deep voice,

Desire, when it stems from the heart and spirit, when it is pure and intense, possesses awesome electromagnetic energy. This energy is released into the ether each night, as the mind falls into the sleep state. Each morning it returns to the conscious state reinforced with the cosmic currents. That which has been imaged will surely and certainly be manifested. You can rely, young man, upon this ageless promise as surely as you can rely upon the eternally unbroken promise of sunrise... and of Spring.

When the student is ready, the teacher will appear—How true! Here was the teacher to show the way to a student who had nearly gone astray! "Accept your destiny and go ahead with your life. You are not destined to become an Air Force pilot. What you are destined to become is not revealed now but it is predetermined. Forget this failure, as it was essential to lead you to your destined path. Search, instead, for the true purpose of your existence. Become one with yourself, my son! Surrender yourself to the wish of God," Swamiji said.

I returned to Delhi and enquired at the DTD&P(Air) about the outcome of my interview. In response, I was handed my appointment letter. I joined the next day as Senior Scientific Assistant on a basic salary of Rs 250/- per month. If this was to be my destiny, I thought, let it be so. Finally, I was filled with mental peace. No more did I feel any bitterness or resentment at my failure to enter the Air Force. All this was in 1958.

At the Directorate, I was posted at the Technical Centre (Civil Aviation). If I was not flying aeroplanes, I was at least helping to make them airworthy. During my first year in the Directorate, I carried out a design assignment on supersonic target aircraft with the help of the officer-in-charge, R Varadharajan, and won a word of praise from the Director, Dr Neelakantan. To gain shop-floor exposure to aircraft maintenance, I was sent to the Aircraft and Armament Testing Unit (A&ATU) at Kanpur. At that time, they were involved in a tropical evaluation of Gnat Mk I aircraft. I participated in the performance assessment of its operation systems.

Even in those days, Kanpur was a very populous city. It was my first experience of living in an industrial town. The cold weather, crowds, noise and smoke were in total contrast to what I was used to in Rameswaram. I was particularly troubled by the ubiquitous presence of potatoes on the dining table, right from breakfast to dinner. To me, it seemed that a feeling of loneliness pervaded the city. The people on the streets had all come from their villages in search of jobs in factories, leaving behind the smell of their soil and the protection of their families.

On my return to Delhi, I was informed that the design of a DART target had been taken up at the DTD&P (Air) and that I had been included in the design team. I completed this task with the other team members. Then, I undertook a preliminary design study on a Human Centrifuge. I later carried out the design and development of a Vertical Takeoff and Landing Platform. I was also associated with the development and construction of the Hot Cockpit. Three years passed. Then the Aeronautical Development Establishment (ADE) was born in Bangalore and I was posted to the new establishment.

Bangalore as a city was in direct contrast to Kanpur. In fact, I feel our country has an uncanny way of bringing out extremes in her people. I suppose, it is because Indians have been both afflicted and enriched by centuries of migrations. Loyalty to different rulers has dulled our capacity for a single allegiance. Instead, we have developed an extraordinary ability to be compassionate and cruel, sensitive and callous, deep and fickle, all at the same time. To the untrained eye, we may appear colourful and picturesque; to the critical eye, we are but shoddy imitations of our various masters. In Kanpur, I saw paan-chewing imitations of Wajid Ali Shah, and in Bangalore it was replaced by dog-walking sahibs. Here too, I longed for the depth and calmness of Rameswaram. The relationship between the heart and the head of an earthy Indian has been eroded by the divided sensibilities of our cities. I spent my evenings exploring the gardens and shopping plazas of Bangalore.

The workload at ADE during the first year of its inception was quite light. In fact, I had to generate work for myself at first, until the tempo gradually built up. Based on my preliminary studies on ground-handling equipment, a project team was formed to design and develop an indigenous hovercraft prototype as a ground equipment machine (GEM). The team was a small working group, comprising four persons at the level of Scientific Assistant. Dr OP Mediratta, Director of the ADE, asked me to lead the team. We were given three years to launch the engineering model.

The project was, by any standards, bigger than our collective capabilities. None of us had any experience in building a machine, let alone a flying machine. There were no designs or standard components available to begin with. All we knew was that we had to make a successful heavier-than-air flying machine. We tried to read as much literature as we could find on hovercrafts, but there was not much available. We tried to consult people knowledgeable in this area, but could find none. One day, I simply took the decision to proceed with the limited information and resources available.

This endeavour to produce a wingless, light, swift machine opened the windows of my mind. I was quick to see at least a metaphorical connection between a hovercraft and an aircraft. After all, the Wright Brothers made the first aeroplane after fixing bicycles for seven years! I saw in the GEM project great opportunities for ingenuity and growth. We went straight into hardware development after spending a few months on the drawing board.

There is always the danger that a person with my kind of background—rural or small-town, middle-class, whose parents had limited education—will retreat into a corner and remain there struggling for bare existence, unless some great turn of circumstance propels him into a more favourable environment. I knew I had to create my own opportunities.

Part by part, subsystem by subsystem, stage by stage, things started moving. Working on this project, I learned that once your mind stretches to a new level it never goes back to its original dimension.

At that time VK Krishna Menon was the Defence Minister. He was keenly interested in the progress of our small project, which he envisioned as the beginning of the indigenous development of India's defence equipment. Whenever he was in Bangalore, he always found some time to review the progress of our project. His confidence in our ability ignited our enthusiasm. I would enter the assembly shop leaving my other problems outside, just as my father used to enter the mosque for prayer, leaving his shoes outside.

But not everyone accepted Krishna Menon's opinion about GEM. Our experiments with the available parts and components did not exactly delight my senior colleagues. Many even called us a group of eccentric inventors in pursuit of an impossible dream. I, being the leader of the "navvies", was a particularly inviting target. I was regarded as yet another

country bumpkin who believed that riding the air was his domain. The weight of opinion against us buttressed my ever-optimistic mind. The comments of some of the senior scientists at ADE made me recall John Trowbridge's famous satirical poem on the Wright Brothers, published in 1896:

. . . . with thimble and thread
And wax and hammer, and buckles and screws,
And all such things as geniuses use; —
Two bats for patterns, curious fellows!
A charcoal-pot and a pair of bellows.

When the project was about a year old, Defence Minister Krishna Menon made one of his routine visits to ADE. I escorted him into our assembly shop. Inside, on a table lay the GEM model broken down into sub-assemblies. The model represented the culmination of one year's untiring efforts to develop a practical hovercraft for battlefield applications. The minister fired one question after another at me, determined to ensure that the prototype would go into test flight within the coming year. He told Dr Mediratta, "GEM flight is possible with the gadgets Kalam now possesses".

The hovercraft was christened Nandi, after the bull ridden by Lord Shiva. For a prototype, its form, fit and finish was beyond our expectation, given the rudimentary infrastructure we possessed. I told my colleagues, "Here is a flying machine, not constructed by a bunch of cranks but by engineers of ability. Don't look at it—it is not made to look at, but to fly with."

Defence Minister Krishna Menon flew in the Nandi, overruling the accompanying officials' concern for his safety. A Group Captain in the minister's troupe, who had logged in many thousands of flying hours, even offered to fly the machine to save the minister from the potential danger of flying with an inexperienced civilian pilot like myself and gestured to me to come out of the machine. I was sure about my competence in flying the machine I had made, and therefore shook my head in negation. Observing this wordless communication, Krishna Menon dismissed the insulting suggestion of the Group Captain with a laugh and signalled to me to start the machine. He was very happy. "You have demonstrated that the basic problems of hovercraft development are solved. Go for a more powerful prime mover and call me for a second ride," Krishna Menon told me. The skeptical Group Captain (now Air Marshal) Golay, later became a good friend of mine.

We completed the project ahead of schedule. We had a working hovercraft with us, moving on an air cushion of about 40mm with a load of 550kg, including the tare weight. Dr Mediratta was visibly pleased with the achievement. But by this time, Krishna Menon was out of office and could not take his promised second ride. In the new order, not many people shared his dream with regard to military applications of an indigenous hovercraft. In fact, even today, we import hovercrafts. The project was mired in controversies and was finally shelved. It was a new experience for me. So far, I had believed that the sky was the limit, but now it appeared that the limits were much closer. There are boundaries that dictate life: you can only lift so much weight; you can only learn so fast; you can only work so hard; you can only go so far!

I was unwilling to face reality. I had put my heart and soul into Nandi. That it would not be used was something beyond my comprehension. I was disappointed and disillusioned. In this period of confusion and uncertainty, memories from my childhood came back to me and I discovered new meanings in them.

Pakshi Sastry used to say, "Seek the truth, and the truth shall set you free." As the Bible says, "Ask and you shall receive." It did not happen immediately, but it happened nevertheless. One day, Dr Mediratta called me. He inquired about the state of our hovercraft. When told that it was in perfect condition to be flown, he asked me to organize a demonstration for an important visitor the next day. No VIP was scheduled to visit the laboratory during the next week as far as I knew. However, I communicated Dr Mediratta's instructions to my colleagues and we felt a new surge of hope.

The next day Dr Mediratta brought a visitor to our hovercraft—a tall, handsome, bearded man. He asked me several questions about the machine. I was struck by the objectivity and clarity of his thinking. "Can you give me a ride in the machine?" he enquired. His request filled me with joy. Finally, here was someone who was interested in my work.

We took a ten-minute ride in the hovercraft, a few centimetres above the ground. We were not flying, but were definitely floating in the air. The visitor asked me a few questions about myself, thanked me for the ride and departed. But not before introducing himself—he was Prof. MGK Menon, Director of the Tata Institute of Fundamental Research (TIFR). After a week, I received a call from the Indian Committee for Space Research (INCOSPAR), to attend an interview for the post of Rocket Engineer. All I knew about INCOSPAR at that time was that it was formed out of the TIFR talent pool at Bombay (now Mumbai) to organize space research in India.

I went to Bombay to attend the interview. I was unsure about the type of questions I would have to face at the interview. There was hardly any time to read up or talk to any experienced person. Lakshmana Sastry's voice quoting from the Bhagawad Gita echoed in my ears:

> *All beings are born to delusion . . . overcome by the dualities which arise from wish and hate . . . . But those men of virtuous deeds in whom sin has come to an end, freed from the delusion of dualities, worship Me steadfast in their vows.*

I reminded myself that the best way to win was to not need to win. The best performances are accomplished when you are relaxed and free of doubt. I decided to take things as they came. Since neither Prof. MGK Menon's visit nor the call for an interview had been of my making, I decided this was the best attitude to take.

I was interviewed by Dr Vikram Sarabhai along with Prof. MGK Menon and Mr Saraf, then the Deputy Secretary of the Atomic Energy Commission. As I entered the room, I sensed their warmth and friendliness. I was almost immediately struck by Dr Sarabhai's warmth. There was none of the arrogance or the patronising attitudes which interviewers usually display when talking to a young and vulnerable candidate. Dr Sarabhai's questions did not probe my existing knowledge or skills; rather they were an exploration of the possibilities I was filled with. He was looking at me as if in reference to a larger whole. The entire encounter seemed to me a total moment of truth, in which my dream was enveloped by the larger dream of a bigger person.

I was advised to stay back for a couple of days. However, the next evening I was told about my selection. I was to be absorbed as a rocket engineer at INCOSPAR. This was a breakthrough a young man like myself dreamed of.

My work at INCOSPAR commenced with a familiarization course at the TIFR Computer Centre. The atmosphere here was remarkably different from that at DTD&P (AIR). Labels mattered very little. There was no need for anyone to justify his position or to be at the receiving end of the others' hostility.

Some time in the latter half of 1962, INCOSPAR took the decision to set up the Equatorial Rocket Launching Station at Thumba, a sleepy fishing village near Trivandrum (now Thiruvananthapuram) in Kerala. Dr Chitnis of the Physical Research Laboratory, Ahmedabad had spotted it as a suitable location as it was very close to the earth's magnetic equator. This was the quiet beginning of modern rocket-based research in India. The site selected at Thumba lay between the railway line and the sea coast, covering a distance of about two and a half km and measuring about 600 acres. Within this area, stood a large church, whose site had to be acquired. Land acquisition from private parties is always a difficult and time-consuming process, especially in densely populated places like Kerala. In addition, there was the delicate matter of acquiring a site of religious significance. The Collector of Trivandrum then, K Madhavan Nair, executed this task in a most tactful, peaceful and expeditious manner, with the blessings and cooperation of Right Rev. Dr Dereira, who was the Bishop of Trivandrum in 1962. Soon RD John, the executive engineer of the Central Public Works Department (CPWD), had transformed the entire area. The St. Mary Magdalene church housed the first office of the Thumba Space Centre. The prayer room was my first laboratory, the Bishop's room was my design and drawing office. To this day, the church is maintained in its full glory and, at present, houses the Indian Space Museum.

Very soon after this, I was asked to proceed to America for a six-month training programme on sounding rocket launching techniques, at the National Aeronautics and Space Administration (NASA) work centres. I took some time off before going abroad and went to

Rameswaram. My father was very pleased to learn about the opportunity that had come my way. He took me to the mosque and organized a special namaz in thanksgiving. I could feel the power of God flowing in a circuit through my father to me and back to God; we were all under the spell of the prayer.

One of the important functions of prayer, I believe, is to act as a stimulus to creative ideas. Within the mind are all the resources required for successful living. Ideas are present in the consciousness, which when released and given scope to grow and take shape, can lead to successful events. God, our Creator, has stored within our minds and personalities, great potential strength and ability. Prayer helps us to tap and develop these powers.

Ahmed Jallaluddin and Samsuddin came to see me off at Bombay airport. It was their first exposure to a big city like Bombay, just as I myself was about to have my first exposure to a mega city like New York. Jallaluddin and Samsuddin were self-reliant, positive, optimistic men who undertook their work with the assurance of success. It is from these two persons that I drew the core creative power of my mind. My sentiments could not be contained, and I could feel the mist of tears in my eyes. Then, Jallaluddin said, “Azad, we have always loved you, and we believe in you. We shall always be proud of you”. The intensity and purity of their faith in my capabilities broke my last defences, and tears welled up in my eyes.

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