10

Seekers

A minor tussle over my services occurred at this time, between ISRO, which was a little hesitant to relieve me, and DRDO, which wanted to take me in. Many months went by, and many letters were exchanged between ISRO and DRDO; and meetings were held in the secretariats of the Defence R&D establishment and the Department of Space to precipitate a mutually convenient course of action. Meanwhile, Prof. Ramanna retired from the office of the Scientific Advisor to Defence Minister. Dr VS Arunachalam, till then Director of the Defence Metallurgical Research Laboratory (DMRL) in Hyderabad, succeeded Prof. Ramanna. Dr Arunachalam was known for his confidence, and he cared little for the intricacies and nuances of the scientific bureaucracy. Meanwhile, I understand that the Defence Minister at that time, R Venkataraman discussed the matter of my taking over the missile laboratory with Prof. Dhawan. Prof. Dhawan also seemed to be waiting for a decisive step at the highest level in the Defence Ministry. Overcoming the niggling doubts that had caused delays over the past year, the decision to appoint me Director, DRDL was finally taken in February, 1982.

Prof. Dhawan used to visit my room in the ISRO headquarters and spend many hours in evolving space launch vehicle projects. It was a great privilege to work with such a great scientist. Before I left ISRO,

Prof. Dhawan asked me to give a talk on the Space Programme Profile in India by the year 2000. Almost the entire ISRO management and staff attended my talk, which was by way of a farewell meeting.

I had met Dr VS Arunachalam in 1976, when I visited DMRL in connection with the aluminium alloy investment casting for the SLV inertial guidance platform. Taking it as a personal challenge, Dr Arunachalam had the investment casting, the first of its kind in the country, made in the incredibly short time of two months. His youthful energy and enthusiasm never failed to amaze me. This young metallurgist had within a short span of time lifted the science of metal-making to the technology of metal-forming and then to the art of alloy development. With a tall and elegant figure, Dr Arunachalam was like an electrically charged dynamo himself. I found him an unusually friendly person with a forceful manner, as well as an excellent working partner.

I visited DRDL in April 1982 to acquaint myself with my potential work site. The Director of DRDL then, SL Bansal, took me around and introduced me to the senior scientists in the laboratory. DRDL was working on five staff projects and sixteen competence build-up projects. They were also involved in several technology-oriented activities with a view to gain lead time for the development of indigenous missile systems in future. I was particularly impressed by their efforts on the twin 30-ton Liquid Propellant Rocket Engine.

Meanwhile, Anna University, Madras, conferred the honorary degree of Doctor of Science on me. It had been nearly twenty years since I had acquired my degree in aeronautical engineering. I was happy that Anna University had recognized my efforts in the field of rocketry, but what pleased me most was the recognition of the value of our work in academic circles. To my delight, the honorary doctorate degree was awarded at a convocation presided over by Prof. Raja Ramanna.

I joined DRDL on 1 June, 1982. Very soon, I realized that this laboratory was still haunted by the winding up of the Devil missile project. Many excellent professionals had not yet recovered from the disappointment. People outside the scientific world may find it difficult to comprehend how a scientist feels when the umbilical cord to his work is suddenly snapped, for reasons totally alien to his understanding and

interests. The general mood and work tempo at DRDL reminded me of Samuel Taylor Coleridge's poem The Rime of the Ancient Mariner:

Day after day, day after day,
We stuck, nor breath, nor motion;
As idle as a painted ship
Upon a painted ocean.

I found almost all my senior colleagues living with the pain of dashed hopes. There was a widespread feeling that the scientists of this laboratory had been cheated by the senior officials in the Ministry of Defence. It was clear to me that the burial of the Devil was essential for the rise of hope and vision.

When about a month later, Admiral OS Dawson, then the Chief of Naval Staff, visited DRDL, I used it as an opportunity to make a point with my team. The Tactical Core Vehicle (TCV) project had been hanging fire for quite some time. It was conceived as a single core vehicle with certain common subsystems to meet the requirements of the services for a quick reaction Surface-to-Air Missile, an anti-radiation Air-to-Surface Missile which could be launched from helicopters or fixed wing aircraft. I emphasized the sea-skimming role of the core vehicle to Admiral Dawson. I focussed not on its technical intricacies, but on its battlefield capabilities; and I highlighted the production plans. The message was loud and clear to my new associates—do not make anything which you cannot sell later and do not spend your life on making one thing only. Missile development is a multi-dimensional business—if you remain in any one dimension for a long time, you will get stuck.

My initial few months at DRDL were largely interactive. I had read at St. Joseph's that an electron may appear as a particle or wave depending on how you look at it. If you ask a particle question, it will give you a particle answer; if you ask a wave question, it will give you a wave answer. I not only described and explained our goals, but also made them an interplay between our work and ourselves. I still recall quoting Ronald Fischer at one of the meetings, "The sweetness we taste in a piece of sugar is neither a property of the sugar nor a property of ourselves. We are producing the experience of sweetness in the process of interacting with the sugar."

Very good work on a Surface-to-Surface missile with a vertical rise-turn straight line climb-ballistic path had been done by that time. I was astonished to see the determination of the DRDL workforce, who, in spite of the premature winding up of their earlier projects, were eager to go ahead. I arranged reviews for its various subsystems, to arrive at precise specifications. To the horror of many old-timers in DRDO, I started inviting people from the Indian Institute of Science, Indian Institutes of Technology, Council for Scientific and Industrial Research, Tata Institute of Fundamental Research, and many other educational institutions where related experts could be found. I felt that the stuffy work centres of DRDL needed a breath of fresh air. Once we opened the windows wide, the light of scientific talent began to pour in. Once more, Coleridge's Ancient Mariner came to mind: "Swiftly, swiftly flew the ship,\ Riding gently the oncoming tide."

Sometime in the beginning of 1983, Prof. Dhawan visited DRDL. I reminded him of his own advice to me almost a decade ago: "You have to dream before your dreams can come true. Some people stride towards whatever it is that they want in life; others shuffle their feet and never get started because they do not know what they want—and do not know how to find it either." ISRO was lucky to have had Prof. Sarabhai and Prof. Dhawan at the helm—leaders who elucidated their goals, made their missions larger than their lives, and could then inspire their entire workforce. DRDL had not been so lucky. This excellent laboratory played a truncated role that did not reflect its existing or potential capabilities or even fulfill the expectations in South Block. I told Prof. Dhawan about the highly professional, but slightly bewildered team I had. Prof. Dhawan responded with his characteristic broad smile which could be interpreted in any way one chose.

In order to accelerate the pace of R&D activities at DRDL, it was imperative that decisions on vital scientific, technical and technological problems be taken quickly. Throughout my career I had zealously pursued openness in scientific matters. I had seen from very close quarters the decay and disintegration that go with management through closed-door consultations and secret manipulations. I always despised and resisted such efforts. So the first major decision which we took was to create a forum of senior scientists where important matters could be discussed

Plate 9 The twin-engine indigenous hovercraft prototype Nandi developed at ADE, Bangalore. As inventor and pilot, I took my rightful place at the controls.

Plate 10 The Christian community in Thumba very graciously gave up this beautiful Church to house the first unit of the Space Research Centre.

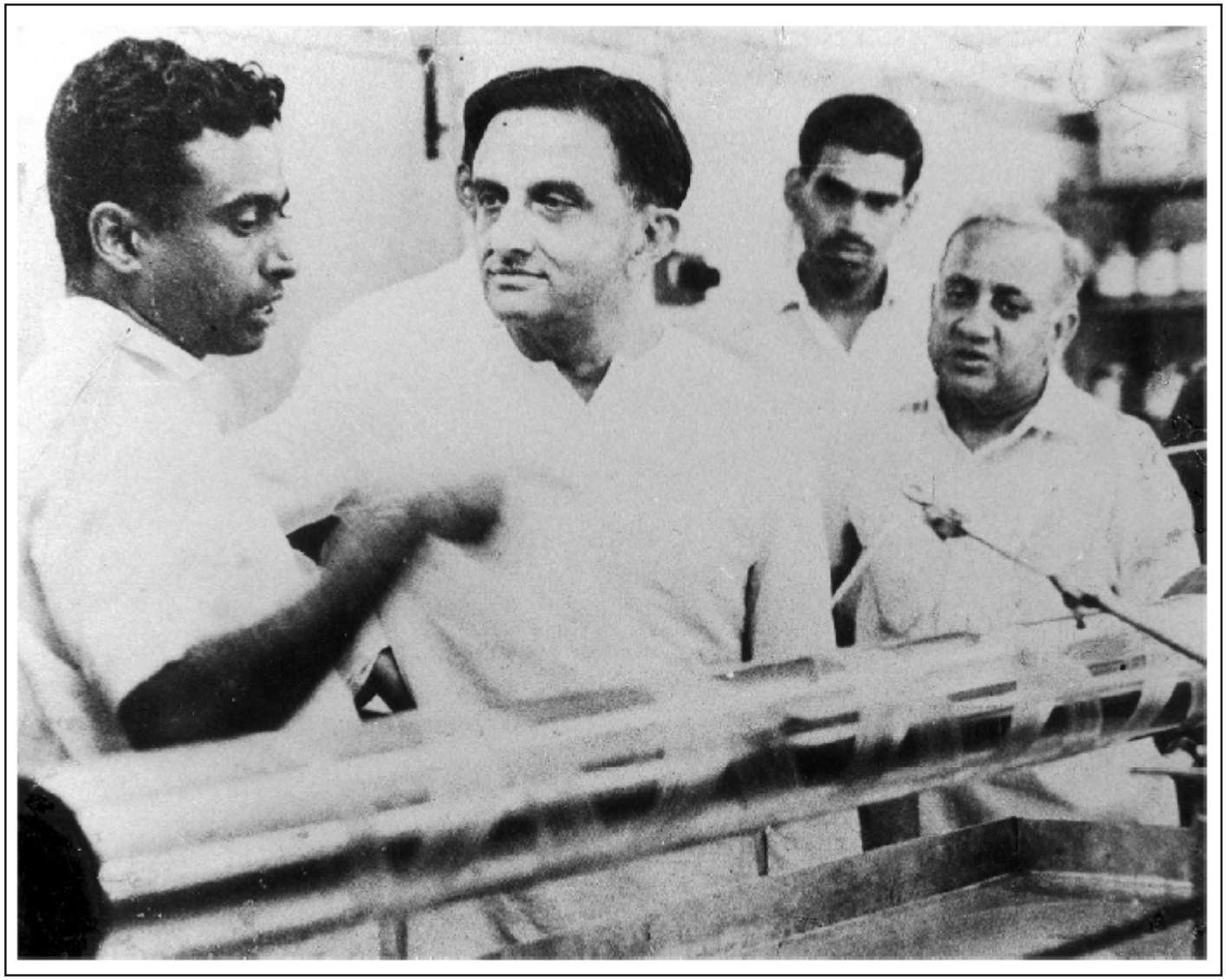

Plate 11 With Prof Vikram Sarabhai, a great visionary and the master planner behind India's Missile Development programme, at Thumba

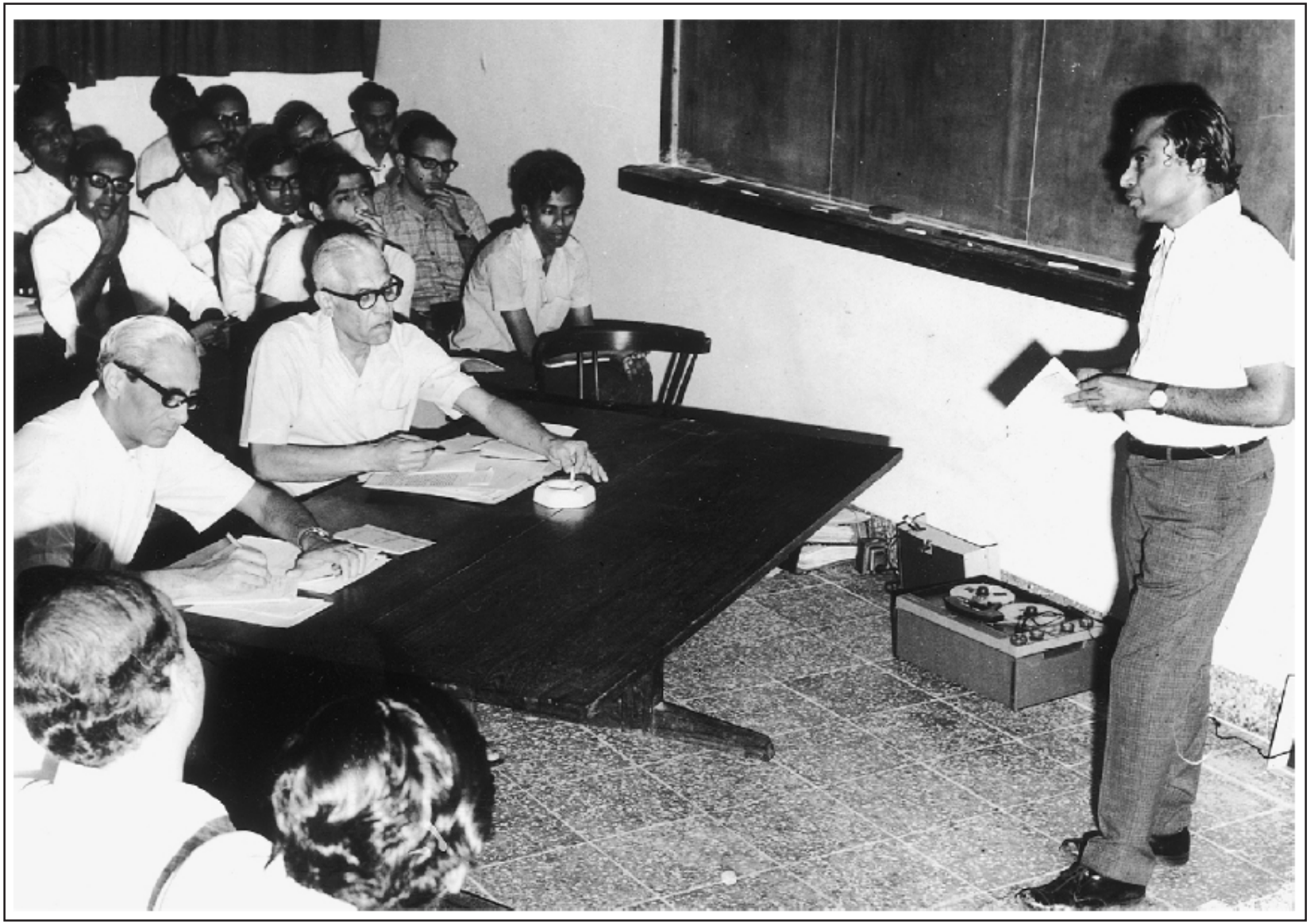

Plate 12 Two gurus of Indian Space Research who mentored and gently guided the young scientists – Prof Satish Dhawan and Dr Brahm Prakash – at one of the SLV-3 review meetings.

Plate 13 A presentation by a member of my SLV-3 team. In an unusual move, I made each of them present their portion of the work—my idea of project management.

Plate 14 Dr Brahm Prakash inspecting SLV-3 in its final phase of integration. He helped me deal with subsequent frustrations in its launching and consoled me when I was at my lowest ebb.

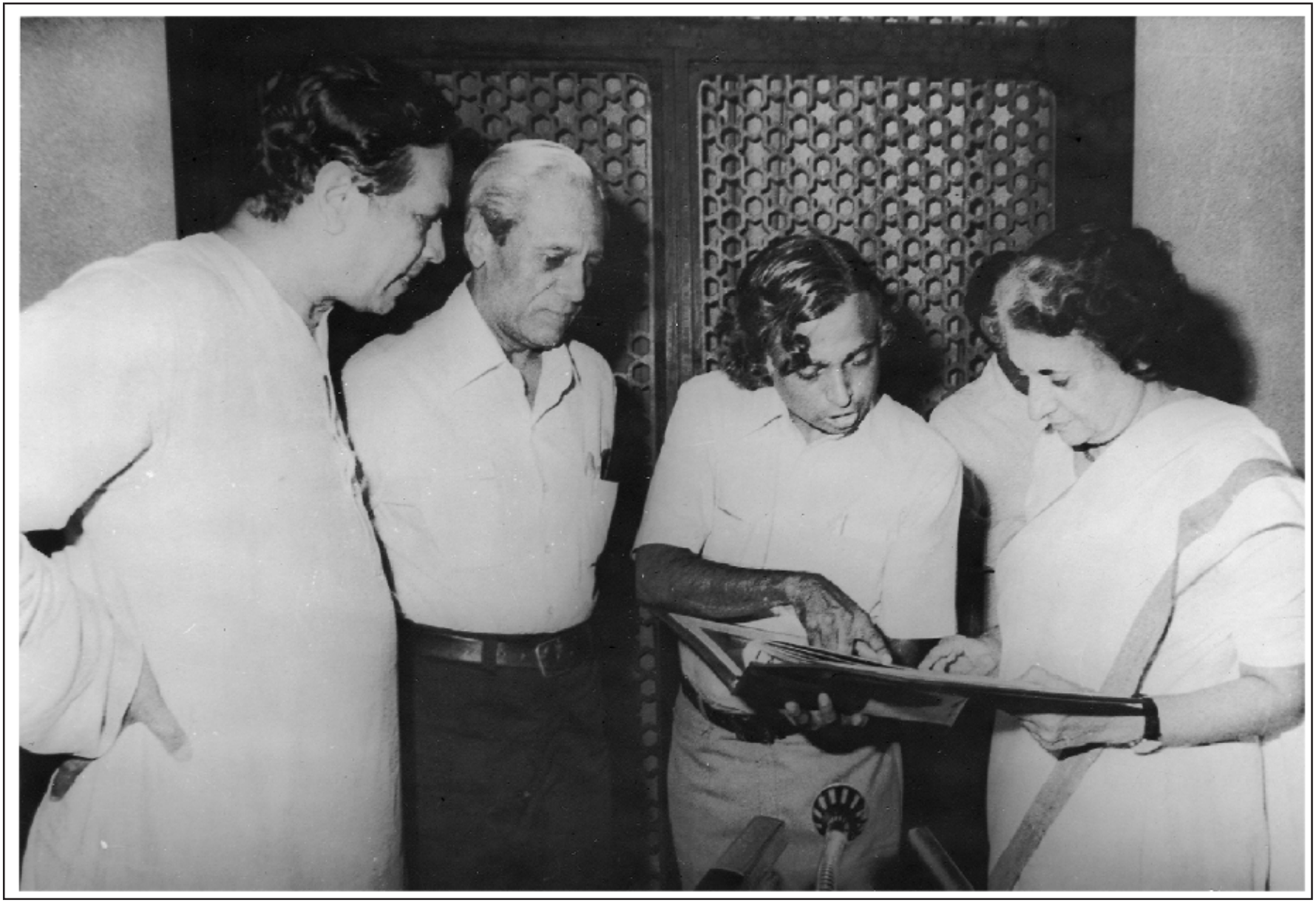

Plate 15 Prof Satish Dhawan and I explaining SLV-3 results to Prime Minister Indira Gandhi.

Plate 16 SLV-3 on the launch pad. This gave us many anxious moments!

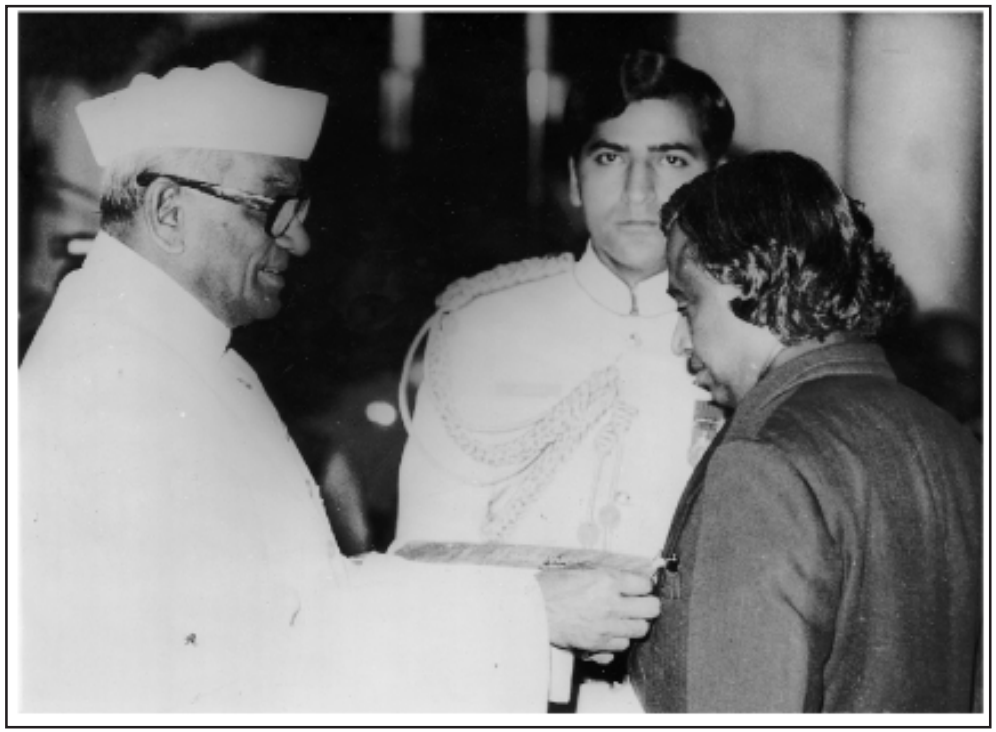

Plate 17 Receiving the Padma Bushan from Dr Neelam Sanjeeva Reddy, then President of India.

Plate 18 Successful launch of Prithvi, the surface-to-surface weapons system.

Plate 19 Agni on the launch pad, my long-cherished dream.

Plate 20 One of the cartoons in the media after the failure of the first two Agni launches.

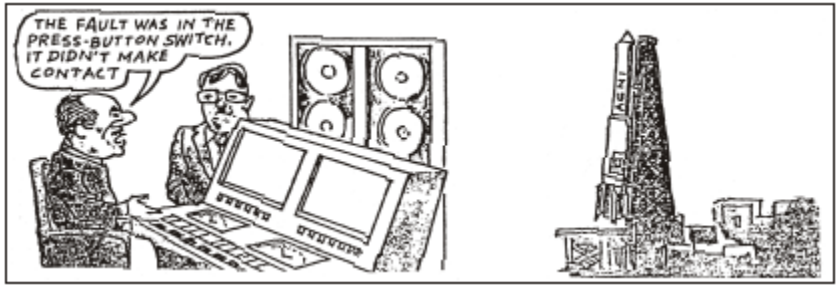

Plate 21 Many a slip between the cup and the lip... .

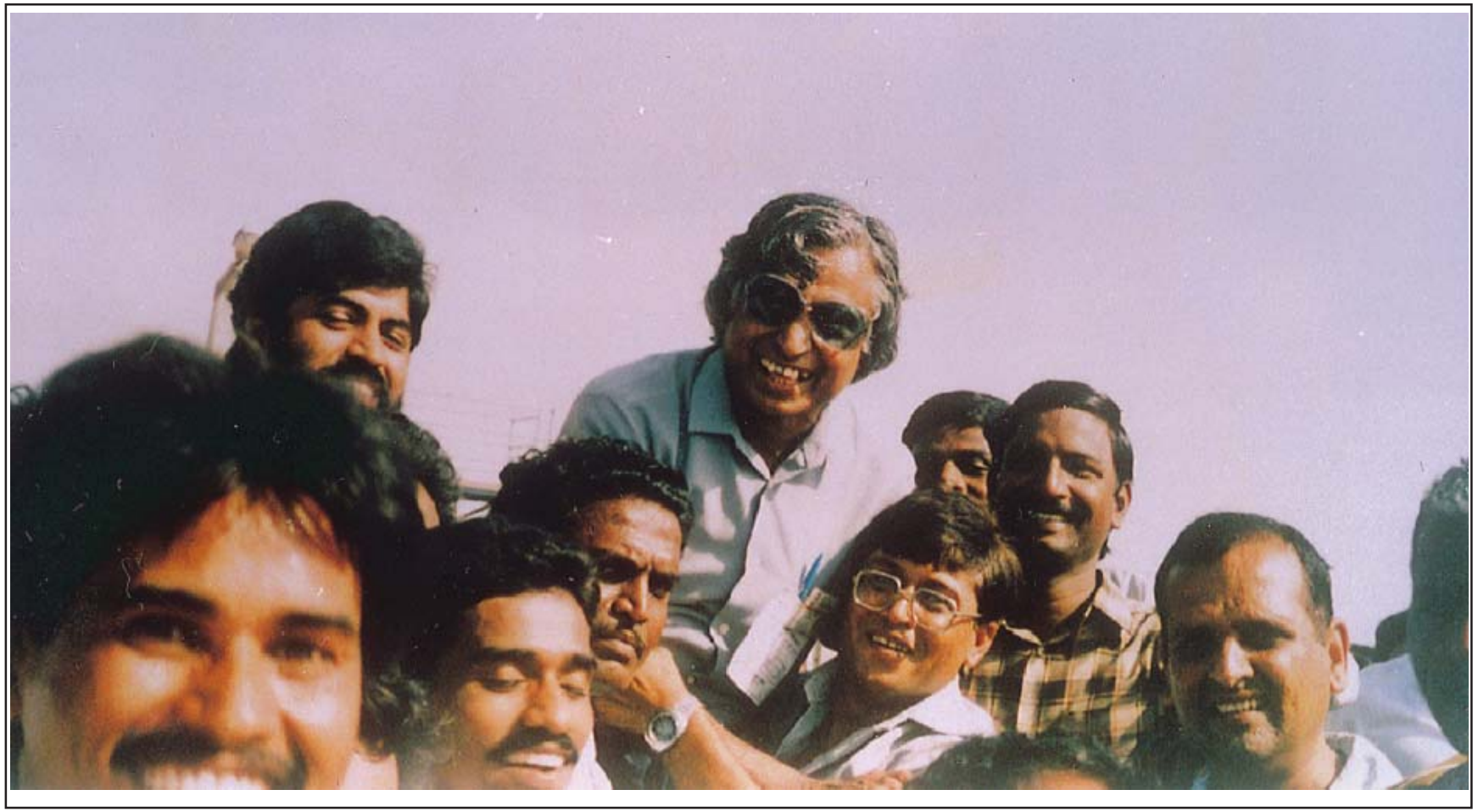

Plate 22 Being carried by a jubilant crowd after the successful launch of Agni.

Plate 23 Receiving the Bharat Ratna from President KR Narayanan.

Plate 24 With three Service Chiefs. To my left is Admiral VS Shekhawat, on his right is General BC Joshi, and Air Chief Marshal SK Kaul.

and debated as a collective endeavour. Thus, a high level body called the Missile Technology Committee was formed within DRDL. The concept of management by participation was evoked and earnest efforts were made to involve middle-level scientists and engineers in the management activities of the laboratory.

Days of debate and weeks of thinking finally culminated in the long-term 'Guided Missile Development Programme'. I had read somewhere, "Know where you are going. The great thing in the world is not knowing so much where we stand, as in what direction we are moving." What if we did not have the technological might of the Western countries, we knew we had to attain that might, and this determination was our driving force. To draw up a clear and well-defined missile development programme for the production of indigenous missiles, a committee was constituted under my chairmanship. The members were ZP Marshall, then the Chief of Bharat Dynamics Limited, Hyderabad, NR Iyer, AK Kapoor and KS Venkataraman. We drafted a paper for the perusal of the Cabinet Committee for Political Affairs (CCPA). The paper was given its final shape after consulting the representatives of the three Defence Services. We estimated an expenditure of about Rs 390 crores, spread over a period of twelve years.

Development programmes often get stuck by the time they reach the production stage, mainly because of lack of funding. We wanted to get funds to develop and produce two missiles—a low-level quick reaction Tactical Core Vehicle and a Medium Range Surface-to-Surface Weapon System. We planned to make a surface-to-air medium range weapon system with multi-target handling capability during the second phase. DRDL had been known for its pioneering work in the field of anti-tank missiles. We proposed to develop a third generation anti-tank guided missile having 'fire-and-forget' capabilities. All my colleagues were pleased with the proposal. They saw an opportunity to pursue afresh activities initiated long ago. But I was not entirely satisfied. I longed to revive my buried dream of a Re-entry Experiment Launch Vehicle (REX). I persuaded my colleagues to take up a technology development project to generate data for use in the design of heat shields. These shields were required for building up capability to make long-range missiles in the future.

I made a presentation in the South Block. The presentation was presided over by the Defence Minister of the time R Venkataraman, and attended by the three Service Chiefs: General Krishna Rao, Air Chief Marshal Dilbagh Singh and Admiral Dawson. The Cabinet Secretary, Krishna Rao Sahib, Defence Secretary, SM Ghosh and Secretary, Expenditure, R Ganapathy were present. Everyone seemed to have all sorts of doubts—about our capabilities, about the feasibility and availability of required technological infrastructure, about the viability, the schedule and cost. Dr Arunachalam stood by me like a rock throughout the entire question-answer session. Members were skeptical and apprehensive of drift—which they felt was common among scientists. Although some questioned our ambitious proposal, everyone, even the doubting Thomases, were very excited about the idea of India having her own missile systems. In the end, we were asked by Defence Minister Venkataraman to meet him in the evening, about three hours later.

We spent the intervening time working on permutations and combinations. If they sanctioned only Rs 100 crores, how would we allocate it? Suppose they gave us Rs 200 crores, then what would we do? When we met the Defence Minister in the evening, I had a hunch we were going to get some funds at any rate. But when he suggested that we launch an integrated guided missile development programme, instead of making missiles in phases, we could not believe our ears.

We were quite dumbfounded by the Defence Minister's suggestion. After a long pause, Dr Arunachalam replied, "We beg for time to rethink and return, Sir!" "You come back tomorrow morning please," the Defence Minister replied. It was reminiscent of Prof. Sarabhai's zeal and vision. That night, Dr Arunachalam and I laboured together on reworking our plan.

We worked out some very important extensions and improvements in our proposal, taking all the variables, such as design, fabrication, system integration, qualification, experimental flights, evaluation, updating, user trials, producibility, quality, reliability, and financial viability into account. We then integrated them into a single function of total accountability, in order to meet the needs of the country's armed forces with an indigenous endeavour. We worked out the concepts of design, development,

production concurrency and proposed the participation of user and inspection agencies right from the drawing-board stage. We also suggested a methodology to achieve state-of-the-art systems after all the years of developmental activities. We wanted to deliver contemporary missiles to our Services and not some outdated inventory of weapons. It was a very exciting challenge that had been thrown to us.

By the time we finished our work, it was already morning. Suddenly, at the breakfast table, I remembered that I was to attend my niece Zameela's wedding at Rameswaram that evening. I thought it was already too late to do anything. Even if I could catch the Madras flight later in the day, how would I reach Rameswaram from there? There was no air link between Madras and Madurai from where I could board the evening train to Rameswaram. A pang of guilt dampened my spirits. Was it fair, I asked myself, to forget my family commitments and obligations? Zameela was more like a daughter to me. The thought of missing her wedding because of professional preoccupations at Delhi was very distressing. I finished breakfast and left for the meeting.

When we met Defence Minister Venkataraman and showed him our revised proposal, he was visibly pleased. The proposal of the missile development project had been turned overnight into the blueprint of an integrated programme with far-reaching consequences. It would have wide-ranging technological spinoffs, and was exactly what the Defence Minister had had in mind the previous evening. Notwithstanding the great respect I had for the Defence Minister, I was not really sure if he would clear our entire proposal. But he did. I was absolutely delighted!

The Defence Minister stood up, signalling that the meeting was over. Turning to me he said, "Since I brought you here, I was expecting you to come up with something like this. I am happy to see your work." In a split second, the mystery surrounding the clearance of my appointment as Director DRDL in 1982 was cleared. So it was Defence Minister Venkataraman who had brought me in! Bowing in thanks, I turned towards the door when I heard Dr Arunachalam telling the Minister about Zameela's wedding being scheduled for that evening at Rameswaram. It amazed me that Dr Arunachalam should bring up this matter before the Minister. Why would a person of his stature, sitting in the all-powerful South Block, be concerned about a wedding which was to take place on a far-flung island in a small house on Mosque Street?

I have always had a high regard for Dr Arunachalam. He has together with a command over language as he displayed on this occasion, an uncanny presence of mind. I was overwhelmed when the Defence Minister located an Air Force helicopter doing sorties between Madras and Madurai later in the day to take me to Madurai as soon as I disembarked at Madras from the regular Indian Airlines flight, which was leaving Delhi in an hour's time. Dr Arunachalam told me, "You have earned this for your hard work of the last six months."

Flying towards Madras, I scribbled on the back of my boarding pass:

Who never climbed the weary league –
Can such a foot explore
The purple territories
On Rameswaram's shore?

The Air Force helicopter landed close to the Indian Airlines aircraft as soon as it arrived from Delhi. Within the next few minutes I was on my way to Madurai. The Air Force commandant there was kind enough to take me to the railway station, where the train to Rameswaram was just about to roll out of the platform. I was in Rameswaram well in time for Zameela's wedding. I blessed my brother's daughter with a father's love.

The Defence Minister put up our proposal before the Cabinet and saw it through. His recommendations on our proposal were accepted and an unprecedented amount of Rs 388 crores was sanctioned for this purpose. Thus was born India's prestigious Integrated Guided Missile Development Programme, later abbreviated to IGMDP.

When I presented the government sanction letter before the Missile Technology Committee at DRDL, they were enthused with fire and action. The proposed projects were christened in accordance with the spirit of India's self-reliance. Thus the Surface-to-Surface weapon system became Prithvi ("the Earth") and the Tactical Core Vehicle was called Trishul (the trident of Lord Shiva). The Surface-to-Air area defence system was named as Akash ("sky") and the anti-tank missile

project Nag ("Cobra"). I gave the name Agni ("Fire") to my long cherished dream of REX. Dr Arunachalam came to DRDL and formally launched the IGMDP on 27 July 1983. It was a great event in which every single employee of DRDL participated. Everybody who was somebody in Indian Aerospace Research was invited. A large number of scientists from other laboratories and organizations, professors from academic institutions, representatives of the armed forces, production centres, and inspection authorities, who were our business partners now, were present on this occasion. A closed-circuit TV network had to be pressed into operation to ensure proper communication between the participants for we had no single place to accommodate all the invitees. This was the second most significant day in my career, next only to 18 July 1980, when the SLV-3 had launched Rohini into the earth's orbit.

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