



Himalayas to Hyderabad: A Journey from Border Roads to Missiles, Microdrones and Cyborgs

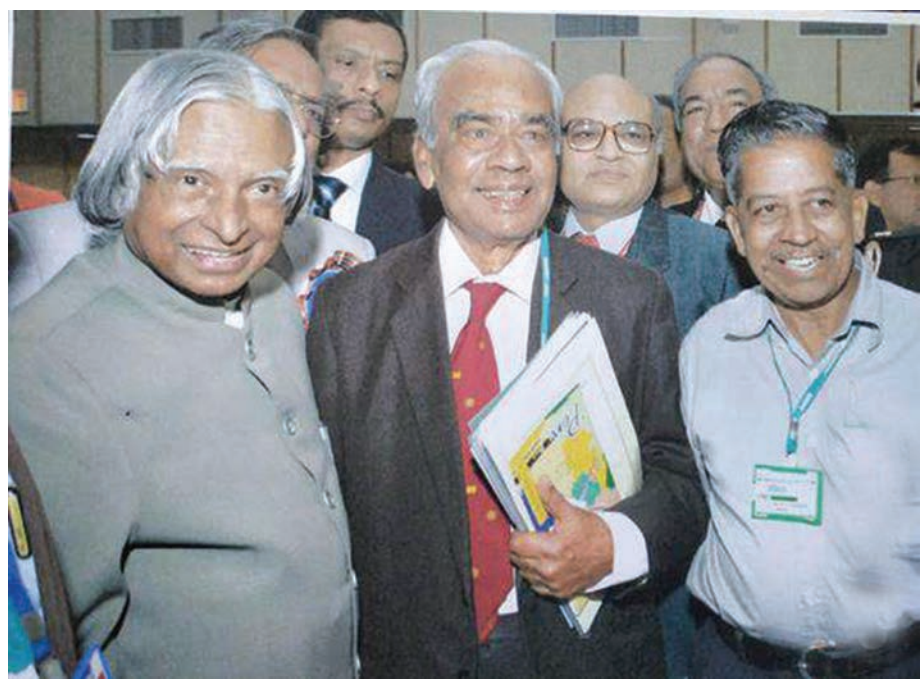


VJ Sundaram
Scharada Dubey



Defence Research & Development Organisation
Ministry of Defence, New Delhi - 110 011

**Himalayas to Hyderabad:
A Journey from Border Roads to
Missiles, Microdrones and Cyborgs**



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Lt Gen (Dr) VJ Sundaram, PVSM, AVSM, VSM (Retd)

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DEDICATION

To my parents Lt Col (Dr) VK Sundaram, MC and Dr Padmasundaram, from whom I imbibed, by their example, the values of Truth, Trust, Integrity, Rectitude and Service to the Nation. To my wife, Nalini, who with her love and similar values understood and sustained me through thick and thin.

To my daughters, Kalpana, Sumana and son, Sananda. All the three understood the importance of being self-reliant (Atmanirbhar).

BORDER ROADS

West Himalayas

Naushera-Rajauri-Poonch



North East Himalayas Dirang-SELA PASS (13,600 ft)-Tawang



MISSILES, MICRODRONES & CYBORGS



Microdrone



Insect Cyborg



Rodent Cyborg

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Foreword

“I got to know Lt Gen. Sundaram (Retd.) only after I came to the senior retirement home (Serene Urbana) some four years ago. He seemed to know about me because of my association with Bharat Electronics Ltd. (BEL), with which he too had some contacts; but by then I had retired.

While exchanging details of our experiences, his in-Defence Research and Development Organisation (DRDO) and mine in BEL (spread over 30 years) we found a lot of commonalities. What amazed me was his background - starting in Defence EME as an officer after completing his engineering education, choosing to move into DRDO (at the risk of a possible set-back to his career). Further to make himself comfortable in multi-disciplinary fields for handling defence projects, he qualified himself formally, with postgraduate courses in electronics, missiles and aeronautics and then a PhD in Aero from the Indian Institute of Science, Bangalore.

In handling the several missile projects in DRDO, he has shown remarkable ability in project management. What impressed me most was the ease with which he built a large number of special teams, all of them very dedicated to the objectives. We can see his fond remembrances of the several men and their names.

Furthermore, unlike many project managers, he has shown keen interest in over-seeing every detail activity by participating in it. I was also impressed by his desire to ensure as little dependence on foreign sources for supplies or know-how, knowing full well all the barriers we usually encounter while working on high security tasks.

His interest and desire for more and more knowledge in associated fields has led him to un-manned aerial vehicles (UAV's), remote monitoring, micro-electronics and even biology. It has been mind-boggling to me.

Of course, in all this, one cannot forget the perfect understanding and support of Mrs Sundaram, without which he could not have reached such heights.

In his biography from “Himalayas to Hyderabad” we can read all that I have mentioned above and much more.

All scientists and technologists should go through this book at least to realise and note that our country could do with many more of his ilk!

May his tribe increase.”



NL Krishnan
Chairman and Managing Director (Retd)
Bharat Electronics Ltd
Bengaluru

30 July 2023

Preface

Himalayas, the very word evokes awe! Himalayas have protected India from enemies for ages. Now our soldiers are there to protect India. I was prepared for this task by the strong foundations (**Chapter 1**) laid by my parents as well as my teachers in schools, colleges and army institutions. To supply the soldiers, we need, not only mule tracks but good roads near our borders with Pakistan and China. Thus, was born 'BRO' the Border Roads Organization of India on 07 May 1960 (**Chapter 2**). My Army (EME) workshop moved out post haste from the Naushera-Poonch Road Project close to the Cease Fire Line with Pakistan in the Western Himalayas. It reached the Foothills of the Eastern Himalayas on 1 June 1960. It became a part of Tusker Road Project of BRO, to meet the threat from China. The Chinese attacked in 1962 and India lost the war. This book covers the saga of BRO, Army Engineers and EME in building the road, in this time, from Foothills to Tawang, crossing Eagles' Nest, Tenga, Bomdila, Dirang, Sela (13,600 ft) and Jang.

I left NEFA in 1962 and after training in Electronics and marriage, returned to the border in the Himalayas followed by postings to other army units (**Chapter 3**).

Hyderabad. In the same year (1962), a laboratory was established in Hyderabad. It was called "Defence Research and Development Laboratory (DRDL). An anonymous name but its charter was - '**Missiles**.' It started with a small Anti-Tank-Missile (ATM) project.

My start in Missiles was in 1967, starting with training (IAT), followed by posting to DRDL, Hyderabad, ME (Aero) in IISc (with project support in ISRO), and return to DRDL. (**Chapter 4**).

AVM VS Narayanan propelled DRDL, in 1972, into a beehive of activity with a successful indigenization project for a Surface-to-Air Missile, Devil

(Chapter 5). He also initiated proposals for 4 tactical missiles before he left DRDL in 1980.

Integrated Guided Missile Development Programme-IGMDP (Chapter 6)

Dr VS Arunachalam became the Scientific Adviser to Raksha Mantri in 1981 and Dr APJ Abdul Kalam took over as Director DRDL in 1982. Together, they revived the proposals for the 4 tactical missiles and Dr Kalam added a 5th proposal - a Technology demonstrator for a Re-entry vehicle from space. The 5 proposals were Prithvi, Trishul, Akash, Nag and Agni. They were integrated as one programme and very strongly recommended by Sri Venkataraman (Raksha Mantri). Called the 'Integrated Guided Missile Development Programme' (IGMDP), it was sanctioned in July 1983, by the Prime Minister, Smt Indira Gandhi. It became a 'Technology War' with all the 'Developed Nations' of the World, thanks to the Missile Technology Control Regime (MTCR).

Prithvi (Chapters 6 to 12) I was asked to lead the Design team for Prithvi and be the Project Director. Many new technologies were involved. One of them, Miniaturization, is essential for missiles and for Prithvi. I strongly supported the development and production of Micro-Electro-Mechanical Systems (MEMS) and Monolithic Microwave Integrated Circuits (MMICs). Other technologies developed and productionized are given in Chapter 7. Further progress till deployment is discussed in Chapters 8 to 12.

The book describes the work done, by total cooperation between, DRDO, ISRO, R&D Laboratories, Armed Forces, Industries (Public/Private), Universities and Government for the Indigenous Design, Development and Manufacture of PRITHVI. It was the first IDDM missile to enter the Indian Army. It was delivered one year ahead of schedule and deployed. Variants have gone to Air Force, Navy, Ballistic Missile Defence and Strategic Forces. Prithvi's indigenous content is 95%. Foundation laid by my parents, education, army training plus support of my wife, children and colleagues made it possible.

Agni, Trishul, Akash, Nag, Brahmos and Tejas are briefly covered in **Chapters 13 to 18**. Critical Materials and components are discussed in **Chapter 19**.

Mini and Micro drones (my NEFA and Disaster Management dreams) were now possible with MEMS and MMICs. So, I initiated a program for Mini/Micro/Bio Air Vehicles in India at an Aeronautical Society meeting in

1998. Most people doubted India's capability. What was done, is explained in **Chapter 20**. Such drones are now used in disaster management, land surveys, agriculture, medical emergencies, security, defence and even social events. Invoking micro, nano and artificial intelligence, they have become game changers in war. Quantum computing will raise the bar higher.

Insect and rodent cyborgs were suggested in 2008. **Chapter 21** describes the work done on these, by Indian universities and the National Design and Research Forum of The Institution of Engineers (India) is described. The Prime Minister of India, Sri Narendra Modi, announced in 2020 at the Indian Science Congress, Bangalore, that a laboratory for nanotechnology, unmanned air vehicles and cyborgs will be opened by DRDO. It is now functional at Hyderabad.

Concluding Remarks (Chapter 22) discusses the lessons learnt and legacies. India will benefit in the future by keeping in mind the past experiences mentioned in this book. We can achieve many things by Collaboration, Truth, Transparency, Trust and becoming Self-Reliant – **Atmanirbhar. India can win a Technology war by realistic long-term planning and hard work.**

Chapter 23 indicates 'Awards'.



30 July 2024

Lt Gen (Dr) VJ Sundaram (Retd)

Acknowledgements

I worked with Dr APJ Abdul Kalam for 20 years from 1982 to 2001 and thereafter 13 years more, informally, but always with the liberty that I could discuss with him freely. A boss with whom you could disagree. One of the tasks he gave me was to write a book about my work in the Army, DRDO and post-retirement. I mentioned to Dr Kalam that we had already brought out a book 'IGMDP' for which I had interviewed him. Dr Kalam said:

“The 'IGMDP' book is an excellent technical document. You must now write a book at a more informal level, including more of the human angle bringing out your childhood, family, education and interactions with project personnel and bureaucracy as well. These are important for success of long-term projects. The two books must complement each other”.

In 2022, Prof YS Rajan suggested that I must write a book including, how Prithvi met both performance and delivery to the Army, ahead of schedules.

They motivated me to write this book. I thank them both.

I thank Scharada Dubey, my co-author who had technical queries and insights into social aspects of the programme as well as better communications of our thoughts.

For the success of Prithvi and IGMDP, I acknowledge with gratitude the following:

1. Vision of all political groups in India.
2. Support of the different Departments of the Government of India.
3. Collaboration between Armed Forces, DRDO, ISRO, Academia, R&D Institutions, Industry (Large/Small and Public/Pvt), Professional Societies.

Specific contributions of groups and individuals are acknowledged in the book at the appropriate places. We were indeed fortunate to have such knowledgeable and committed groups and persons to help us.

In addition, I would like to acknowledge the extraordinary contributions of the following persons who contributed to our success.

1. AVM VS Narayanan-who laid the foundation for the core manpower and development fabrication of missiles at DRDL (under Project Devil).
2. Dr Raja Ramanna who as the Scientific Adviser to the Raksha Mantri, raised DRDO to a more dynamic mode of working.
3. Dr VS Arunachalam, whom I consider as the Pragmatic Scientific Adviser and gave the fillip to the missile program.
4. Dr Abdul Kalam who welded the program and the teams to achieve success.
5. Sri M Natarajan, who in 2007, formed a committee with me as Chairman, and 6 members to write the book, 'IGMDP'. It was brought out by DESIDOC of DRDO and released in 2008 by the Raksha Mantri, Sri AK Antony, in the presence of the Prime Minister, Dr Manmohan Singh. The writing of the book gave me the opportunity to look at the programme again, from an alternate perspective.

I thank Dr VK Saraswat who helped and complemented me in so many aspects and brooked no nonsense in execution.

I thank Sri NL Krishnan, former Chairman, Bharat Electronics Ltd, Bangalore for the many discussions we had, as well as, for kindly going through the book and writing the foreword.

I thank my wife, Nalini, our daughter, Dr Sumana Navin and our son-in-law Dr Navin Jayakumar for their valuable suggestions in the writing of this book.

I thank Sri BS Sankar Reddy, Manager, National Design and Research Forum for all the help in editing and help in bringing out this book.

I thank Dr Nageswara Rao, Director, DESIDOC, Alka Bansal, Ajay Kumar, Rajesh Kumar and Gunjan Bakshi for all the suggestions and help in editing and progressing the publishing of this book.

CHAPTER 1

Childhood and Education

Velacheri Jagadesan Sundaram was born on 07 October 1935 to Dr Padmasundaram and Dr VK Sundaram. At that time, Dr Padmasundaram was in charge of the Women's Hospital, Chikmagalur (Fig. 1.1). She would go away through forests to coffee plantations, even late in the night, to attend to critical patients and delivery cases, unmindful of the tigers and bears she was likely to encounter on the way. Her acts of courage and commitment would be recounted, even decades later, by nostalgic mothers.



Figure 1.1. Assuming Charge Dr Padmasundaram (Sitting on right), Women's Hospital-1935.



Figure 1.2. Dr VK Sundaram's Scouts VJ Sundaram - on the ground (1938).

My father, Dr VK Sundaram, her classmate in Madras Medical College, was also working in the same town at the District Hospital. My father was a passionate scouter who inculcated the scout motto, "**Be Prepared**" as well as the spirit of service to the country and discipline in his scouts (Fig. 1.2). At scout meetings he would play, on his hand-wound gramophone, Rabindranath Tagore's song 'Jana Gana Mana.' It would become India's National Anthem when India became independent.

Bhama was the first cousin whom I met (Fig. 1.3). She had just lost her father. Her mother, Radha, went back to finish her high school and became a teacher to be independent. An early example to me of courage. Meanwhile, Bhama was looked after by my mother at Chikmagalur. Bhama was mischievous and played pranks on me but she taught me slokas of Ganesha which I recite even now (2023) during prayers. During holidays – more cousins would join us.

When World War II started in 1939, Dr Padma Sundaram was in the Government Hospital at Davanagere (Fig. 1.4) and Dr VK Sundaram joined the Indian Medical Service of the Indian Army at Rawalpindi (now in Pakistan). I stayed with my mother.

Lt (Dr) VK Sundaram was posted as the Medical Officer, to the 2nd Battalion of the 5th Gurkha Rifles (Frontier Force), better known by the shorter version 2/5 GR (FF). It had been raised at Abbottabad, in the North West Frontier of India in a highly malarial zone.



Figure 1.3. Bhama+the family dogs (1939).



Figure 1.4. Davanagere (1940).

Chairs: *Eswaran, Kuppaswamy Mudaliar (Thatha), VK Sundaram, Padmasundaram, Radha (mother of Bhama and Shanthi).*

Ground: *Narendran, Shanthi, VJ Sundaram, Bhama, Kumaresan - all cousins.*

The unit had a very high incidence of malaria and when the unit was moved to Secunderabad in 1941, relapses were occurring at such an alarming rate that the Commander of the Army Division was considering asking for replacement of the battalion. Dr Sundaram who joined the battalion took on the formidable task of nursing the battalion back to health and achieved remarkable results. **The battalion history states ‘The debt of**

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About the Monograph

The monograph describes the start of India's journey in 1959 to build strategic roads in the Himalayas, at our borders in J&K with Pakistan and in Arunachal Pradesh with China. Pandit Nehru, visiting our road project to Sela, Bomdila, Tawang in 1961, said at Bomdila, "I give roads first priority". In March 2024, our current PM, Sri Narendra Modi, opened the Sela Tunnel! Next, the book covers India's journey, at Hyderabad, for self-reliance in missiles for India with Indigenous Design, Development and Manufacture (IDDM). It includes Devil, Prithvi and its variants, Agni, Trishul, Akash, Nag, Ballistic Missile Defence, and the joint development with Russia of Brahmos. In spite of the Missile Technology Control Regime (MTCR), imposed by the G8 countries, Prithvi (Army) was cleared for induction, one year ahead of schedule with 95% indigenous content. It is the 1st IDDM missile to enter our Armed Forces. Prithvi and its variants, Agnis, Akash, Brahmos and Tejas have been deployed. Radars, made for Trishul, are used by the Indian Navy. Nag trials are on. The book discusses the indigenous development of critical technologies (for the Light Combat Aircraft (Tejas), which were restricted after the Pokhran II tests. Finally, the book describes the initiation in 1998 of the National Programme for Mini, Micro Air Vehicles (Drones) and Cyborgs – an activity blessed by Sri Narendra Modi, in The Indian Science Congress (2020) at Bangalore. Many mini drones are being made in India. R&D in Rodent Cyborgs is in progress.

About the Author



Lt Gen (Dr) VJ Sundaram, BSc and BE (Mech), Mysore University. He joined Army in 1957. In service, he completed post-graduate courses in Electronics and Missiles. Obtained ME and PhD in Aeronautics from Indian Institute of Science. Worked in Border Roads and Infantry Divisions.

Moving to Missiles at DRDL in 1968, he led the design team for Prithvi and was its first Project Director. He was Mission Director for 50 Prithvi/Dhanush launches from 1988 to 2013. He took over from Dr Kalam as Director of DRDL & RCI and Chairman, Programme Management Board of India's Missile Program (1992-97). He was Chairman, Committee for Indigenization of Critical Technologies of LCA (1998-2001). He initiated and still nurtures micro drones and cyborgs.



Smt Scharada Dubey, holds a B.A. in English and Psychology, as well as M.A. degrees in both English and Sociology. She is an accomplished author and communication consultant, having published 19 books, which include profiles of notable Indian figures such as Presidents, Prime Ministers, and social activists.

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