

Satish Dhawan: A transformational leader of the Indian space programme

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It is a profound honour and privilege to write about the legendary Satish Dhawan, born a century ago, who made pioneering contributions in diverse domains of education, science, technology and engineering in India. I cherish my close association with him since 1981, being a young manager doubling up as his staff analyst at the ISRO Headquarters (1981–84), the ‘young chap in the adjacent room’ at Antariksh Bhavan (1989–97), and his doctoral student (1996–99). He is reverentially and plentifully referred in my biography – ‘*My Odyssey*’¹.

A distinguished student

Satish Dhawan (born 25 September 1920) had an exemplary combination of academic credentials, including a PhD (Aeronautics and Mathematics) from the prestigious Graduate Aerospace Laboratories at the California Institute of Technology (GALCIT), USA by the age of 31. It is amazing to read the obituary penned by his research supervisor Hans Liepmann² (a student of Theodore von Karman who founded the Jet Propulsion Laboratory) in 2002.

‘...From his previous scholastic records, we expected excellence in scholarship and class work, but there was so much more. Satish was immediately accepted and respected by this highly competent and proud group of young scientists. He showed an unusual maturity in judging both scientific and human problems, a characteristic that today is called ‘leadership quality.’ ...He was a natural mentor for younger people...’.

Dhawan is one of the six persons (along with von Karman and Liepmann) named as ‘Legends of GALCIT’.

An admired academician

Dhawan chose Bangalore as his ‘Karma Bhoomi’, starting his illustrious career at the Department of Aeronautics at the Indian Institute of Science (IISc), Bangalore in 1951; blooming soon to head the Department and rising to the coveted seat of Director of IISc at the age of 42, with a glorious innings of about two decades. Roddam

Narasimha³ elucidates the transformation of IISc during 1962–81 under the stewardship of Dhawan.

Indeed, Dhawan engraved great legacy as a passionate teacher, a demanding research guide, a pragmatic engineer renowned to be the father of experimental fluid dynamics research in India and an academic leader par excellence.

Induction into Indian space programme

A man of conviction and courage, Dhawan had an uncanny ability to say ‘no’ to even enviable national roles that sought him. Once he narrated the reasons to turn down the invitation to head a national R&D organization but added ‘when Vikram invited me to join Atomic Energy Commission, I accepted it’. He became a member of the Atomic Energy Commission (then overseeing the space programme) in January 1971. Vikram Sarabhai was Chairman of the Atomic Energy Commission and Ex-Officio Secretary of the Department of Atomic Energy, besides being the Director of Physical Research Laboratory (PRL) and Chairman of Indian Space Research Organisation (ISRO) nucleated in PRL.

An enterprising and versatile scientist of international repute, Sarabhai founded India’s space programme in 1962, with an indomitable vision. He attracted brilliant and inspired scientists and engineers to the fold of ISRO. Around these young ones, Sarabhai had created a network



Radhakrishnan accompanying Prof. Satish Dhawan, Chairman of ISRO during visit to Vikram Sarabhai Space Centre in September 1984.

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of institutions at Thumba and Ahmedabad to venture into bold initiatives in rocketry and space applications with a spirit of self-reliance.

When the untimely demise of Sarabhai happened in December 1971, Dhawan agreed to step in and lead the space programme from Bengaluru while continuing as the Director of IISc.

The Resolution of the Government of India, dated 1 June 1972, setting up the Space Commission made the Secretary of the newly created Department of Space (DoS) as the Ex-Officio Chairman, along with a Member-Finance, a top bureaucrat and a couple of renowned scientists. This instrument of empowerment (on the lines of the Atomic Energy Commission) gave considerable freedom from the ‘needlessly inelastic rules’ of a typical Department in the Government. Aside, PRL, that had nurtured ISRO within, also got shifted to DoS.

As Secretary of the newly created DoS and Chairman of the Space Commission, Dhawan started his innings by rededicating the Commission to the advancement of the many tasks ahead and to the lofty ideals towards which Sarabhai strived. M. G. K. Menon and Brahm Prakash were by his side as members of the Space Commission.

Restructuring and consolidation

An astute institution-builder, Dhawan carried on the process of consolidation and restructuring of ISRO units, facilities and programmes, taking cue from the special dispensations available to the Department of Atomic Energy and building over it to meet the imperatives of running the space programme.

Meanwhile, Menon, who held the fort as Chairman of ISRO during the interregnum, had worked in tandem with Dhawan to establish the Vikram Sarabhai Space Centre (VSSC) by unifying all of ISRO’s entities at Thumba engaged in research and development, pilot plants, facilities and the rocket launching station.

Brahm Prakash, a legendary metallurgist from Bhabha Atomic Research Centre and a former senior contemporary of Dhawan at IISc had been persuaded to take over as Director of VSSC. During the 1970s, we, at Thumba, observed two brilliant minds working in unison, with admirable professional bond and mutual respect all through. Brahm Prakash continued to contribute, even after superannuation, as a member of the Space Commission and ISRO Council besides heading a few crucial national committees. For posterity, it was a great lesson.

ISRO’s units and entities at Ahmedabad pertaining to the Satellite Instructional Television Experiment (SITE) and space applications, were integrated as the Space Applications Centre (SAC) with a few homogeneous verticals; Yash Pal (from TIFR) was brought in as its Director. The Solid Propellant Booster Plant, propulsion test facilities and launch station facilities coming up at Sriha-

rikota island were unified into one entity, the ‘SHAR Range’, with Y. Janardana Rao taking charge of it. Devendra Lal (from TIFR) was appointed as the new Director of PRL.

Soon, Dhawan decided to set up a Council of ISRO as the functioning body to deal with the detailed consideration of the implementation of various programmes and projects, leaving the Space Commission to take major matters of policy and issues related to long-range planning. The ISRO Council, set up in 1972, comprised of Dhawan (as Chairman), Directors of the Centres at Thumba and Ahmedabad, the two senior bureaucrats of DoS and the Scientific Secretary, drafted for the ISRO Headquarters.

A seminal decision of Dhawan in 1972 was (i) to preserve the research personality of the pre-existent ISRO as a monolithic, full-Government organization instead of converting into a unit of DoS, and (ii) Chairman of the Space Commission and Secretary of DoS taking charge to head ISRO, as its Chairman. The considerations behind the decision are elaborated in his interview published in the book *From Fishing Hamlet to the Red Planet*⁴.

That troika model of (a) Space Commission, the apex policy-making body; (b) DoS, responsible for governance and (c) ISRO, the executive body of the space programme – all headed by one individual, stood the test of time as a unique organizational edifice nationally and among global space establishments. Convincingly, the troika model has been a key success factor for ISRO’s sustained excellence so far in the frontiers of space science, technology, engineering and applications.

In practice, it is like the driver being enabled to operate the troika of accelerator, brake and clutch of the vehicle to be steered. And, the onus is on that individual to make doubly sure that these dispensations are not mixed up or misused. Dhawan organized the headquarters of ISRO/DoS with diligent processes and people to facilitate and balance the three-in-one role donned by him.

ISRO became a Government organization from 1 April 1975. I remember vividly opting to be part of this new entity, like almost all other early recruits to the ISRO fraternity.

Towards an ‘ISRO’s way of working’

Dhawan adapted the Senate’s model of IISc to ISRO for democratic and decentralized techno-managerial decision-making process. Ardent on transparency and accountability, he adeptly held ‘town hall’-style technical reviews for major space projects, where active participation of at least a dozen academicians was quite regular. He practiced a process where any informed ‘young chap’ could speak up on issues of science, technology and engineering. He encouraged debates and productive conflicts to bring out the best possible outcome; an

outcome binding on all concerned. That was democracy complemented with discipline.

Dhawan nurtured a convention where the right expert chairs a body rather than on considerations of seniority or title. He opted to make Menon as Chairman of the PRL Council, and remained there as a member. To ensure national participation in space sciences, he set up the Advisory Committee on Space Sciences (ADCOS) and inducted its Chairman (R. R. Daniel from TIFR) as a member of the ISRO Council, on par with the Directors of ISRO Centres and PRL.

Classic project management structures, centred around an empowered project director with multi-layer oversight mechanisms (e.g. project-specific management boards, programme-oriented management councils), came to stay. Multiple projects were interleaved with functional groups in a matrix structure. Importantly, specialist teams from multiple Centres of ISRO were put together for a project, with one of them designated as the lead Centre. These were seminal steps to ensure synergy in a large, complex, high technology and multi-disciplinary project environment.

Right from the first orbital launch (of SLV-3), Dhawan had set up an intrinsically autonomous 'Launch Authorization Board', entrusted and empowered with decision-making on the merit of flight worthiness of the launcher and satellite, preparedness of launch complex and tracking systems as well as overall readiness of the mission. Brahm Prakash chaired this Board in the initial years and set the tune for posterity. This mechanism has contributed decisively to the array of successful Indian space missions till date.

Programmes, strategy, focus and outcome

Dhawan orchestrated a clever strategy, through a national consultative process of 1972, to focus and execute three distinctive and parallel steps: (i) to demonstrate utility of satellites for the nation's development (SITE and STEP); (ii) to learn to build satellites (Aryabhata, Bhaskara-1/2, APPLE), and (iii) to grow in rocketry to launch satellites from India itself (SLV-3). All these targets were accomplished during 1975–80.

To expedite this pursuit, the ISRO Scientific Satellite Project, headed by U. R. Rao, was restructured in 1976, as a full-fledged ISRO Satellite Centre. The SHAR Range was elevated as the SHAR Centre in 1977 (renamed as Satish Dhawan Space Centre from September 2002) with N. Pant moving in as the Director. Both of these Centre Directors became members of the ISRO Council, the apex body of ISRO. The multifarious activities of VSSC were gradually grouped, by 1976, into a few functional domains, headed by Directors of Groups, beside the flagship SLV-3 headed by a Project Director.

All activities of VSSC, albeit a few long-term ones, were tightly focused, from the mid-1970s, towards the

prime goal of an 'all solid', 'open-loop guided' SLV-3, an inescapable imperative of that time. Nevertheless, Dhawan supported the development of liquid engine technology (i.e. Vikas Engine, adapted and uprated for PSLV, GSLV and GSLV Mk3) through a novel model of cooperation with the French space industry. Rightly so, the cryogenic engine development had to be moved to the background in that process lest ISRO would have spread its human resources and facilities in the propulsion area too thin for any tangible outcome.

Further, by the late 1970s, the Indian National Satellite (INSAT) system took shape as a multi-departmental mechanism to be piloted by DoS, but with collective decision-making, assigned responsibilities and authority and plan allocations flowing from the user sectors. The initial batches of INSAT-1 spacecraft were built abroad. INSAT-1B (1983) marked the beginning of operational satellite service in India.

Alongside, Dhawan catalysed and facilitated the space industry to emerge as ISRO's partner to build rockets, satellites and ground equipment. The ebullient technology transfer and industry interface group at the Headquarters effectively prodded to rope in industry (public and private sectors) for manufacturing and production. Transfer of spin-off technology to non-space sector was admired. The RESPOND scheme catalysed the academic community to respond to the research problems in space science, technology and applications.

'It was Vikram's vision; I only executed it'

Sarabhai's vision was executed with commendable diligence, focus and national significance under Dhawan's leadership. That is history. But, it was the magnanimity of Dhawan to state: 'It was Vikram's vision, I only executed it'. His foreword in an ISRO publication of 1979 reads thus⁵:

'Vikram Sarabhai was the gifted architect of the Indian Space Programme. It was his imagination backed by an extraordinary capacity to band together people – scientist, engineers and others – that brought ISRO into being with the objective of using Space Technology for the benefit of India. This collection of his writings and speeches gives a glimpse of his vision.'

Quite, a rare gesture. To my mind, these two legendary scientists with congruence of purpose and mutual admiration, steering ISRO in that sequence, made the difference by shaping India's odyssey in 'rocket science' and an exceptional organizational culture.

Charting the future of space programme

The 'Space Research and Development Profile for the decade 1980–90', approved by the Government in

1981, carried the stamp of Dhawan's foresight and pragmatism.

Its central objective was set forth thus⁶:

'The main thrust of the Space programme for the eighties will be towards establishing National Systems using space technology for telecommunications, television, meteorology, and remote sensing. The indigenous development of various application satellites, their payloads and the capability to launch these satellites is integral to this objective.'

Dhawan took concrete steps to move forward with the specific targets set forth for 1980–90, notably the continuation of SLV-3, realization of ASLV and development of PSLV; the development of IRS-1 satellite, and concomitant preparation for utilizing its data, establishment of a national natural resources management system; amalgamation of National Remote Sensing Agency with DoS; upgradation of the launch complex and spacecraft control network and finally the completion of feasibility studies and project formulation for indigenous INSAT-2.

Finally, he demonstrated his dexterity for a smooth transition. He was an amalgam of an ideal successor and remained as an ideal predecessor.

A humanist boss

Rajan, a close associate of Dhawan at ISRO as his Scientific Staff Officer and Scientific Secretary wrote thus in 2005 (ref. 7):

'Two unique features of Professor Dhawan's style was the inherent respect he accorded to the views of others and his ability to blend change with continuity. Though he held very powerful positions (Chairman Space Commission, Director IISc) he never ever used his position to make the point that "he knew better because he was so and so". He could be tough and rigorous in how he viewed what you said but never overbearing or condescending. This was his attitude not only to his peers but to everybody around him. This inherent modesty, often bordering on humility, seems to have been born out of a blending of a kind of scientific temper and an almost Buddha like approach to life and knowledge.'

A transformational leader

Dhawan deciphered grand patterns, trends, turning points of a long time horizon and visualized pragmatic scenarios for future in the frontal domains of science, technology, engineering and education with the cleverness of an architect.

As a leader, he fits into the definition of a 'transformational leader' by Burns⁸ and Bass⁹, truly a rarity globally,

scoring high on all its four parameters of: (i) 'inspirational motivation' with consistent vision and vision to the team members, (ii) 'intellectual stimulation' to be innovative and creative, (iii) 'idealized influence' as a role model to the followers to emulate, and (iv) 'individualized consideration' to the followers as a mentor, empowering them to make decisions and providing the much-needed support for their implementation.

In fact, Dhawan went one step further to demonstrate: 'leader takes responsibility for failures and credit for success goes to the followers, though he was not hesitant to deliver stern messages for consistent non-performances'. He was an epitome of dignity and equanimity too.

My reverential role model

Dhawan handpicked me in 1981 from the Avionics Group of VSSC for the ISRO/DoS Headquarters. He welcomed in his characteristic style 'Join the conspiracy'. A few months later, our interactions became more frequent and the chemistry seemed to match well. I cherish being his last doctoral student during 1996–99; I treasure the rare lessons from him that raised my inner strength.

In a rare feat, a decade later, I was privileged to ascend the troika seat that Dhawan adorned once and notably following renowned space stalwarts – U. R. Rao, K. Kasturirangan and G. Madhavan Nair.

I stepped into Antariksh Bhavan in the evening of 31 October 2009, taking charge as Secretary of DoS, Chairman of the Space Commission and hence the Chairman of ISRO. Besides a copy of my 'Road Map to ISRO', I had carried a framed photograph of Dhawan that kept reminding, all through, an advice that he gave me during the doctoral study: 'Never do anything that I won't do'. I strived to follow that gospel.

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