

Satish Dhawan – A Creative Teacher

A P J Abdul Kalam



A P J Abdul Kalam, President of India, worked with the Indian Space Research Organization 1964-1982, and with the Defence Research and Development Organization 1958-1963 and again 1982-2001. In 1997 the Government of India conferred on him its highest civilian award, the Bharat Ratna. On many occasions during his long and illustrious career he worked closely with Professor Satish Dhawan. He recounts these events in the following pages, written from a personal point of view.

M K Chandrashekar

When I think of the teaching qualities of Prof. Satish Dhawan, my thoughts go back to my days in the ADE during 1959-1961. At that time we were designing the Hovercraft “Nandi”. One of the typical design problems of Hovercraft was the design of a contra rotating propeller. I knew how to design a propeller, but I had no clue about the design of a contra rotating one taking into account the duct effect. I asked Dr. Mediratta, the then Director of ADE, whether I could seek the help of Prof. Dhawan for this design, since my friends had told me about his great teaching abilities. Dr. Mediratta agreed and I went to Prof. Dhawan. At that time Prof. Dhawan used to work in a small room in the IISc campus. When I asked him for help in the design, he said he would teach me how to design a contra rotating propeller, but I would have to come to him for ten Saturdays from 2 to 3 in the afternoons for learning the design. It was a great teacher's offer. I was jubilant and started attending the classes. He taught me how to design it. After the first lecture, before beginning the second one, he asked me critical questions pertaining to the first lecture. He tested the degree of my assimilation and application potential. With this background, I attended all the ten lectures and I developed the confidence that I could design the contra rotating propeller.

Keywords

Satish Dhawan, SLV-3, ISRO, INSAT, IRS

After completing the course he asked me to design the propeller. He reviewed the design and asked me to go ahead with fabrication, I needed Andaman Padauk¹ for the fabrication but it was not readily available. He helped me to get the Padauk from HAL. After getting it I proceeded with fabrication involving multilayer sandwich construction and assembly. Once it was assembled, he asked me to take it to the test bed and start testing. I started facing some teething problems, particularly in the clearance between the duct and the propeller tip at the maximum velocity point. I solved the problem with the help of Prof. Dhawan and reached a stage of smooth test phase. The propeller went through 50 hours of continuous testing without any problem. Once we reached this stage of trouble free operation, Prof. Dhawan was very happy.

¹ A kind of wood.

The unique feature of his teaching was that he created a spirit of research and inquiry in me, taught me how to design without giving me the design. He enriched my design capability by following through the implementation and test phase, just by asking more and more questions and making me find the answers for them. This enhanced my self confidence in taking up future design problems. Also during the teaching phase, he permitted me to use the IISc library and gave me five books. For the first time I saw such a big library. My love for libraries and books was triggered by this single learning experience from Prof. Satish Dhawan.

A Beautiful Day

18th July 1980 is a memorable day for the entire space community of India. This was the day the space scientists put a 40 Kg Rohini satellite in a low earth orbit through SLV-3 which took off at 0805 hrs; within minutes the satellite was in orbit. This was a great accomplishment for our scientists, especially after an unsuccessful earlier mission on 10th August 1979.

There was jubilation all around. People were thrilled. They were shouting, hugging and lifting each other and were emo-

Abbreviations used

ADE – Aeronautical Development Establishment
 IISc – Indian Institute of Science, Bangalore
 HAL – Hindustan Aeronautics Limited, Bangalore
 SLV – Satellite Launch Vehicle
 ISRO – Indian Space Research Organization
 INSAT – Indian National Satellite
 IRS-2 – Indian Remote Sensing Satellite.
 DRDO – Defence Research and Development Organization, Hyderabad
 DRDL – Defence Research and Development Laboratory

tionally charged. This was the time Prof. Dhawan took me aside and said that we should go to a silent place. Both of us went to the launch pad and sat on the launcher. We watched the waves of the Bay of Bengal in silence.

After a few minutes Prof. Dhawan said to me: "Kalam, you know you have been working hard for the last eight years. You encountered a number of problems and failures. You faced them all with utmost courage, patience and perseverance. For all the efforts that you put in, today we have got the results. I want to thank you for your excellent work. I will remember it and cherish it".

I had never come across such a beautiful day till then. In the din of loud external jubilation of the entire space community, Prof. Dhawan and I were enjoying the intrinsic beauty of the mega event.

Vision for the Space Programme

After completion of the SLV-3 programme in July 1980 Prof. Dhawan asked me to take up the Space Launch Vehicle Directorate at ISRO Headquarters. The major task given to me and my team was to bring up the space programme for remote sensing and communication satellites linking the corresponding launch vehicle systems including the launch complex. We worked for nearly ten months linked with Vikram Sarabhai Space Centre, ISRO Satellite Centre, Sriharikota and Space Applications Centre. We designed and developed a six degree of freedom simulation model integrating the progress of technology in different disciplines. During this phase Prof. Dhawan used to drop into my office frequently to suggest ideas for the evolution of the space programme. We would explain to him the possible scenarios on the black board. We practically clinched the profile of the spectrum of communication and remote sensing satellites required for the nation during the next two decades. One evening he sat down and drew the entire road map for the space programme and depicted them in his own hand in

two simple graphs which then became the driving force for the entire Space Department for the next two decades. The two graphs are given in p.60.

As visualized by Dhawan, as a communication satellite a multi-mission INSAT was built, launched and operationalised. The INSAT series later reached a 2000 Kg satellite with a large number of transponders.

In the remote sensing area IRS-2 has established our satellite's unique performance and can compete with world class satellites.

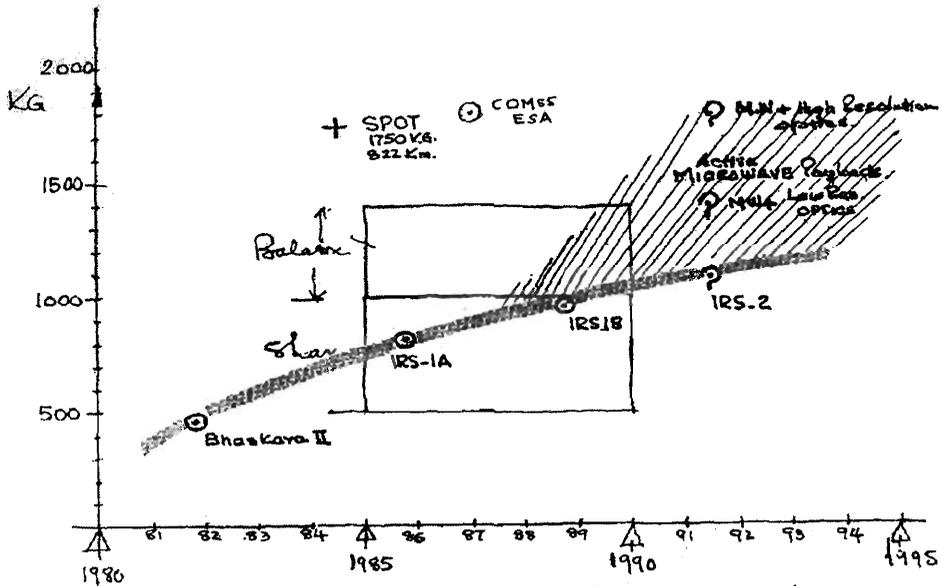
Just when we completed the work relating to the drawing up of the 'vision' for the space programme my posting to DRDO, Hyderabad came up. Prof. Dhawan was reluctant to relieve me for this task. However, after the Defence Minister made a special request he agreed to spare me to take over as Director, DRDL, Hyderabad on 1st June 1982. I had worked in ISRO for almost two decades, and Prof Dhawan gave me a unique send off. On 31st May, 1982, he organized an ISRO Council meeting which was attended by all the Directors of ISRO Laboratories and headquarters. He asked me and my team to present the Space Vision profile to the ISRO Directors. At the end of the presentation he broke the news about my posting to Hyderabad as Director, DRDL and converted the Council meeting into a send off meeting followed by a good dinner.

Prof. Dhawan's elegant way of making me a part of the future space programme coupled with a warm send off enriched my life and made me ever grateful to the institution for which I had worked for so long.

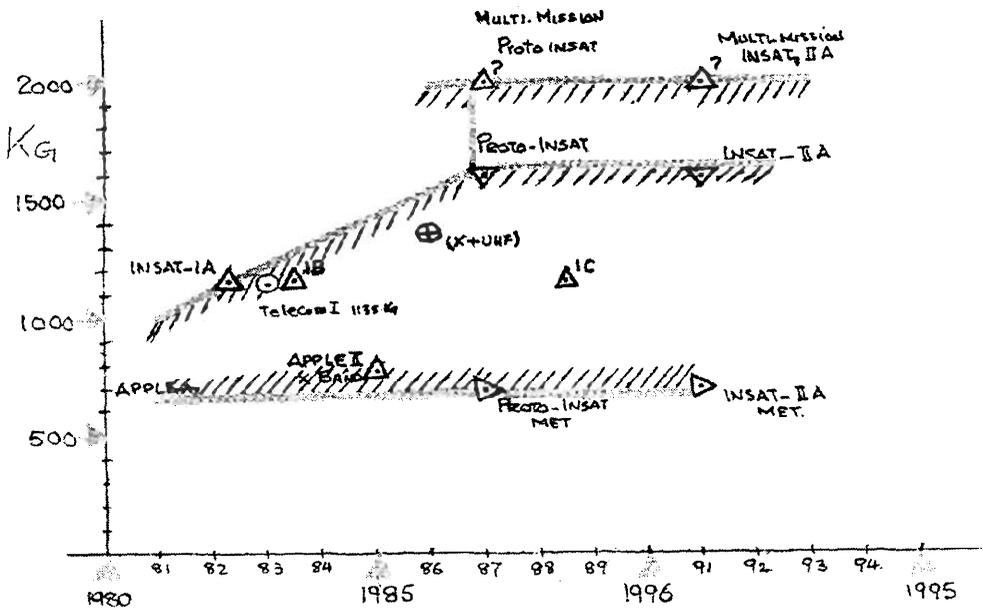
Prof. Satish Dhawan: a Lover of Nature

Prof. Dhawan selected me as Project Director of SLV-3 – the first satellite launch vehicle to inject the Rohini satellite into a near earth orbit. During the ten years of my close association with him at ISRO, I had observed a unique quality in him. Apart from his excellence in science, technology and management





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aspects, Prof. Dhawan was a lover of Nature, particularly of birds.

The roaring sea waves at Thumba (Site of the Vikram Sarabhai Space Centre) and at Sriharikota (Satellite Launch site of ISRO) and the dynamics of bird flight made Prof. Dhawan compare Nature's marvels with human life. When the sea becomes rough in cyclonic conditions, it generates a lot of turbulence and pain all around as we had witnessed in Sriharikota. Human beings should take a lesson from this and learn how to be calm in such a situation and be dynamic to encounter and solve problems.

I still remember two events which brought Nature very close to him.

The first event was the selection of the SLV-3 launch complex in Sriharikota, with launch pad, block house and rocket integration facilities. When the site and building plans were presented to Prof. Dhawan at Sriharikota near the site, he found that it needed removal of ten thousand trees, and it was a great shock to him. He was so much concerned about the trees that he discussed with the team for two hours to find out the methodology by which the mission requirements could be met without uprooting all the trees. After prolonged discussions, a new site configuration emerged needing a removal of only a thousand trees. He agreed to this solution stating that they should make arrangements to plant ten thousand saplings in that area. And also for the first time an official order was issued to all the Directors of ISRO Establishments stating that "no tree should be removed without specific clearance from the Chairman of the ISRO, in any Establishment". Today we find Nature smiling at us, full of trees and flowers, when we walk through any ISRO Establishment.

The second event occurred during the Satellite Launch Vehicle programme. Prof. Dhawan used to visit all the establishments once in a month. He would review the projects continuously for four hours, visit the work centers and project sites and give



suggestions for the timely completion of the projects. Generally he would not be available for two periods in a day, namely 4.30 to 8.00 in the morning, and 4.00 to 7.00 in the evening. During these periods he used to go into the forest with the photographer, Mr. K R Seetharam, with a small bag on his shoulder and a water bag. After visiting the forest area, he would walk all through it looking at various types of birds and their dynamics of flight. One day during his forest visit he observed a fleet of Siberian birds and then for the whole day he talked about the dynamics of that bird!

His research established the framework for flying, wing profiles of the bird, structure and action of muscles, wing shapes and the flapping configuration for different types of birds with reference to the weight. His research was a masterpiece and he presented the results at scientific forums. For the first time the world came to know about the beautiful research work relating to flapping kinematics, hovering flights, gliding and soaring, power requirements of the flight including the establishment of drag coefficients for zero lift birds.

The most important conclusion concerning bird flight for a flapping wing dynamics was: If an animal like a bird has to fly, aerodynamic efficiency and power have to be combined with structural strength and muscular energy, and the weight must be kept at a minimum. Birds are the most biologically successful group of animals that have ever existed. The song birds are particularly successful survivors because of their great maneuverability in flight.

Prof. Satish Dhawan was well known as a researcher in boundary layer phenomena in subsonic and supersonic regions. And he was also well known for experimental aerodynamics. This expertise combined with his love for nature, particularly birds, resulted in a book called "Bird flight". Prof. Dhawan's work has created a human dream of having a flying system with flapping wings. Definitely in a decade, flapping wing aircraft will fly with high maneuverability.

Address for Correspondence

A P J Abdul Kalam
President of India
Rashtrapati Bhavan
New Delhi