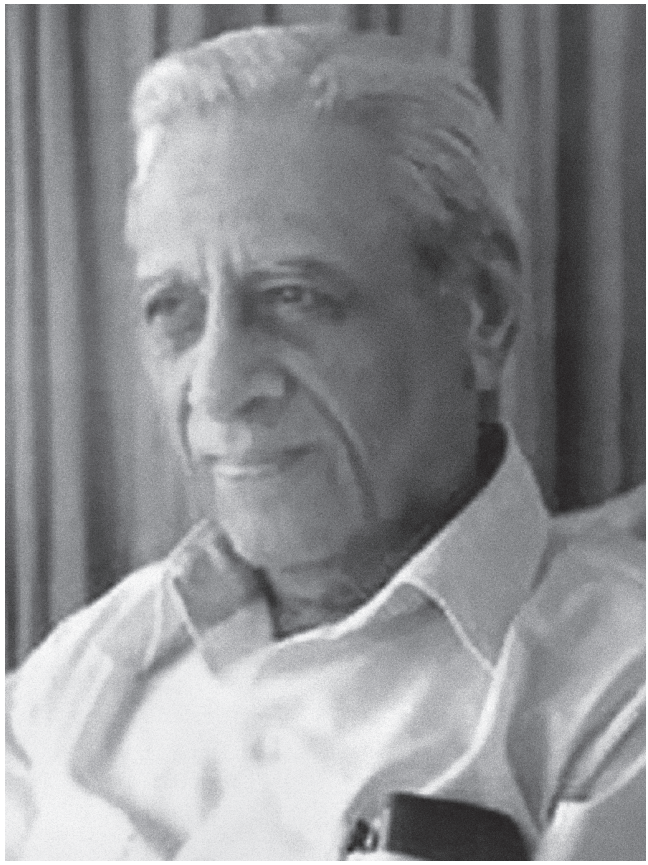

SATISH DHAWAN

1920–2002

Elected in 1978

"Leadership in aerospace research and education and achievement in management of space applications and development programs."

BY RODDAM NARASIMHA AND
VENKATASUBBIAH SIDDHARTHA

SATISH DHAWAN, India's pioneering aerospace scientist and engineer, chair of the Indian Space Research Organization (1972–1984), and director of the Indian Institute of Science (1962–1981), passed away at age 81 on January 3, 2002. His career covered virtually the complete spectrum of professional involvement—teaching, scientific research, technology development, management and leadership of learned societies and large national institutions, and scientific advice to government at the highest levels—often in more than one of these capacities at a time.

Satish was born on September 25, 1920, in Srinagar, Kashmir. His parents came from professional families, and his father, Devi Dayal, retired as a respected judge of the High Court in Lahore (now in Pakistan). Satish graduated from the University of Lahore with an unusual combination of degrees: a BA in physics and mathematics (1938), an MA in English literature (1941), and a BE (with honors) in mechanical engineering (1945).

In 1946 he travelled on a government scholarship to the United States, where he obtained an MS from the University of Minnesota (1947) and then an MS in aeronautical engineering (1949) and a PhD in aeronautics and mathematics (1951) at the California Institute of Technology, with the distinguished fluid

dynamicist Hans W. Liepmann as his advisor. The year he moved from Minnesota to Pasadena saw the Indian subcontinent in the throes of a violent partition, and Satish's family left Lahore for Delhi (never to return).

The Caltech Years

Dhawan wrote his thesis about the direct measurement of skin friction on a flat plate, using an ingenious floating element device whose deflection due to the wall stress was measured electronically. With Liepmann and Anatol Roshko he coauthored one of the first studies of shock wave–boundary layer interaction ("On Reflection of Shock Waves from Boundary Layers," National Advisory Committee for Aeronautics Report 1100, 1952). These investigations made an immediate impact on the understanding of the dynamics of compressible laminar and turbulent boundary layers, and are still mentioned in many current text books.

In an obituary on Dhawan, Liepmann commented on his "unusual maturity in judging both scientific and human problems," his sense of humor, and the way "he was immediately accepted and respected by the highly competent and proud group of young scientists" who worked with Liepmann at the time. Dhawan's technical gifts, charming personality, and cheerful and positive attitude left a deep and lasting impression on everybody he met at Caltech.

Research at the Indian Institute of Science

Dhawan left the United States in 1951 to join the Indian Institute of Science (IISc) as a scientific officer. He rose rapidly to become professor and head of the Department of Aeronautical Engineering in 1955 and, in 1963, director of the institute.

In the department he built the first high-speed aerodynamics and boundary layer laboratories in the country, both of them intended chiefly for research. Early studies involved

transition from laminar to turbulent flow, in particular the intermittent transition zone, on a flat plate and in pipes and channels, base flows at high speeds, and a turbulent boundary layer undergoing some form of relaminarization in a Prandtl-Meyer expansion. Also studied were wall jets, axisymmetric and three-dimensional boundary layers, separation bubbles, and transonic flows, among others. Dhawan appeared to be working toward establishing a solid base from which any of a range of important topics in aeronautical fluid dynamics could be studied in India.

All of this work was carried out at low cost, with ingenious development or adaptation of the materials, skills, and instrumentation available at the time. With 100-horsepower compressors running supersonic tunnels and galvanometers and optical instruments measuring the flow in the tunnels, the laboratories conveyed at once (to a casual visitor) an impression of both science and engineering—scientific instrumentation in aid of acquiring engineering data (something unusual in India of the 1950s). The research conducted in the laboratory was always inspired in some way by the problems facing the newly born aircraft industry in Bangalore, but usually grew quickly into basic research in its own right.

In retrospect, it is clear that Dhawan was driven by a desire to establish a tradition of research in India along the lines of the engineering science or mechanics that had emerged in Europe and the United States. But the high-speed laboratory was also a pilot project for the design and operation of the larger wind tunnels built later at the National Aeronautical Laboratory (established by the Government of India in 1959), with several of Dhawan's IISc graduates playing a key role in the development of facilities in NAL's early years.

Around 1970 Dhawan was called upon by the government to assess the airworthiness of the HS-748 aircraft then flying for Indian Airlines. The task involved a large number of flight tests of a kind that were new in India, as well as innovative evaluation of acceptable airworthiness requirements using a computer simulation of a stochastic data-based model of an

airline fleet, describing general performance deterioration during flying service, but undergoing improvement soon after nearly periodic maintenance checks.

Dhawan's approach to all of this work was characterized by ingenious design, meticulous execution, and cautious interpretation.

Directing IISc

As IISc director Dhawan devoted much time to the establishment of a number of new scientific programs—in automation and control theory, materials science, molecular biology and biophysics, computer science, technology for rural areas, theoretical physics, applied mathematics, solid state chemistry, and atmospheric sciences. He persuaded several distinguished Indian scientists working elsewhere in the world to join the institute, and persuaded the faculty to reform the educational program that had changed little during the previous decade or two.

His long tenure at the institute—the longest ever for an IISc director—transformed it from a relatively laid-back campus with some excellent people in certain areas to one humming with new ideas in a wide variety of subjects, with fresh young faculty and a great many more students. From 11 departments and 5 sections with a recurring annual budget of about 5.5 million rupees (about $1 million) in the early 1960s, IISc grew to some 40 departments and units and a recurring annual budget of 100 million rupees by the time Dhawan left.

Space Science and Technology

Dhawan was on a well-earned sabbatical at Caltech in 1971–1972 when he was called upon to take over India's fledgling space program after its visionary founder Vikram Sarabhai passed away at an early age. Dhawan responded by setting out his views about the space program that India should pursue, its administrative structure, and the need to keep it away from Delhi. If these were acceptable he would be honored to lead

the program. The government agreed, and a new structure was set up involving a policymaking Space Commission, an administrative arm of the government called the Department of Space, and a science and technology agency called the Indian Space Research Organization (ISRO)—all three headed by one person.

Over the next decade Dhawan directed India's space program through a period of rapid growth and great achievement. Beginning with two Indian satellites launched from Russia, the first successful Indian launch took place in 1980 (the program director of this launch, A.P.J. Abdul Kalam, went on to become president of the Republic in 2002).

Perhaps the most striking and unusual of the many satellites launched in this period was APPLE (the Ariane Passenger Payload Experiment, 1981), which must have been (at that time) one of the most extensive societal projects carried out from a space platform anywhere in the world. Among other things, it beamed special educational and social content to 12 of the most backward areas in the country in the language spoken in each area. This project, a favorite of Satish's, was a tangible expression of his keen sense of the importance of promoting social justice in India. (Incidentally, having been a lifelong fan of Arthur Clarke's books and his vision on the uses of satellite technology, Satish was absolutely delighted to locate an antenna in Clarke's house in Sri Lanka!)

In addition, pioneering experiments in remote sensing and satellite communications led to operational systems that became a part of Indian life. It is no surprise that, by the 1980s, the Indian space program came to be seen as a model of technology development and application in the country.

Dhawan's qualities as a leader won much national and international acclaim. His unimpeachable integrity and sense of moral order and social justice were the bases for both his management style at ISRO and the staff he selected to assist him at headquarters. Technical reviews at various levels, conducted with expertise from outside ISRO (particularly from academia), helped identify alternative technical approaches in every project.

Dhawan demanded of his scientists, particularly the senior ones, the same standards of scientific integrity that he set for himself. Perhaps his US education and experience enabled him to embark on a management innovation that was, at the time, revolutionary for an Indian government organization. His touchstone in decision making was "Will this advance or retard the engineering effort, given the enabling technology available?"

Honors

Dhawan was elected to the Indian Academy of Sciences in 1970 (which he also served as president, 1977–1979), and both the US National Academy of Engineering and Indian National Science Academy in 1978. He became a foreign honorary member of the American Academy of Arts and Sciences in 1972. He received honorary doctorates from the Cranfield Institute of Technology (UK) and several Indian academic institutions, and was named a distinguished alumnus of Caltech in 1969 and an IISc honorary fellow in 1981.

He was recognized by numerous Indian professional societies and the government for his services to the nation, culminating in the Padma Vibhushan (the country's second highest civilian honor) in 1981. He also received the Indira Gandhi Award for National Integration in 1999 as "one of our foremost scientists, teachers, and national builders,…who has made multidimensional contributions to scientific education, research, policy formulation, and implementation and is deeply concerned with the solution of national problems through the use of science."

Conclusion

In his diverse roles during his professional career, Dhawan transformed every institution he led or advised and left his own special imprint on each of them. His great human qualities, combining personal charm with a deep commitment to social values and an extraordinary objectivity in management,

led several generations of students, colleagues, and administrators to efforts that they would otherwise not have undertaken.

His own education had integrated science, technology, and the humanities, and so did his life. A powerful combination of ability, integrity, and personality enabled him to both do and promote science, work for the state as well as society, and manage megatechnology while also championing little science. He left a precious legacy for his country, and did so at a special period in its history.