Prof. Satish Dhawan

(Teacher, Scientist, Researcher,Thinker,Guide)

Prasad B S

Space Books Series for Children
U R Rao Satellite Centre,
Bengaluru-560017

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Chairman's Message

Scientific literature for children isan important and distinctive literary work. It is to observe all the happenings around us from a scientific point of view and explain it in simple literature which can make a high school student understand complex subjects like astronomy, satellite and rocket technology is highly appreciable.

In this regard, U R Rao Satellite Centre, a prestigious research Institute in Bengaluru, has launched a new program called "Space Books Series for Children" through which it plans to bring out pocket books on "Space Technology Space Science and Space Scientists". This book,

which is now in your hands, is one of the books of the Series. This is a significant step in the direction of enriching science literature for children.

In order to inculcate interest in science amongst children, it is necessary to explain various scientific and technical topics in a simple language. Similarly, it is necessary to explain the scientific achievements of our organization to the masses in a simple language and create awareness about it. The present "Space Books Series for Children" programme will fulfil both these requirements.

I congratulate the Director of U R Rao Satellite Centre for conceiving and implementing this programme. I hope more books will come out in the coming days and reach more children and common people.

S. Somanath
Chairman, ISRO

Director's Message

Satellite, space science, technology and related topics should be explained in a simple language so that everyone can easily understand it. Such an effort will provide essential and authentic information specially to the young talents of rural areas. Thus, it is a significant step in providing them a better opportunity and building a great future.

It is obvious that this work should be done by the skilled and experienced scientists of U R Rao Satellite Centre who have been working in this field of technology for five decades. As a part of

educating children about space science and technology, U R Rao Satellite Centre is bringing out a “Space Books Series for Children”.

In response to this idea, our enthusiastic colleagueshave written books on these topics. It is a pleasure to have seven pocket books in this series in your hands today. I congratulate them for their efforts and wish for the success of the programme. I wish that the students develop interest and curiosity in these subjects. I also wish that they understand the principles, get inspiration and create a better future, thereby contributing to the development of the country and the all-round development of society. I am fully confident that our objective will be realized and the desired result will be achieved.

M Sankaran

Director

U R Rao Satellite Centre

Editorial board

Space Books Series for Children

Dear Children,

U R Rao Satellite Centre (URSC) celebrated its Golden Jubilee in 2022. On this occasion, the Karnataka Rajyothsava Committee of URSC had taken up the task of publishing a series of Kannada books on Space and Space Scientists which have been translated to English for the benefit of students across the country.

Our committee plans to publish pocket books in simple language to make school children easily understand many topics like space science, rocket and satellite technology, etc. These books are written by the scientists of our organization. As the first set of books in this series, seven books are published. Our aim is to provide electronic version of the books to children through our website.

Our committee is grateful toShri M Sankaran, Director, URSC who is the key person behind the successful realization of these books. Our heartfelt thanks to Shri HN Suresh Kumar, Shri KV Govinda, Dr. M Ravindra, Smt. Lalitha Abraham, Smt. Anuradha S Prakasha, Smt. Sreedevi S who reviewed all seven books in detail and suggested suitable modifications.

We are grateful to all the authors who took time off from their work and authored the books. We are thankful to all colleagues of our Centre who helped us to bring out these books.

If you read them and give your suggestions and comments, we will be able to incorporate the same in the next set of books in this series.

RamanagoudaVNadagouda

President

Author's Note

The purpose of this book is to introduce school children to ISRO and space technologies. Towards this purpose U R Rao Satellite Center (ISRO) is publishing mini books to inform the school children about the basic aspects of space science.

The dream of space science in India was laid by Dr. Vikram Sarabhai. It was Prof. Satish Dhawan who led India's space sector and achieved such a feat that the whole world was amazed. He was also a great teacher and scientist who directed the Indian Institute of Science for nineteen years. Prof. Satish Dhawan's hard work and dedication are the main factor which made ISRO & IISc, Internationally famous.

This book briefly describes the childhood, life events, career and achievements of Prof. Satish Dhawan, who laid a solid foundation for space science in India.

If children become interested in learning more about science, space, satellites and great personalities who have made great achievements in the field of space, then the goal of this book will be fulfilled. I hope that the children of today will continue to carry out research in the field of space and improve the lives of common people.

My heartfelt thanks to Shri M Sankaran, Director, U R Rao Satellite Centerfor giving me an opportunity to write this book. Salutations to Shri. Ramanagouda V Nadagouda, Chairman, Editorial Board of this book series and all the seniors and colleagues of the organization. I am also thankful to Mrs. Archana and my family for helping me in writing this book. Special thanks to Mr. Shivprakash B and Dr. B R Nagendra who encouraged me to write the book.

Prasad B S

Content

1. Introduction

Indian Space Research Organisation (ISRO) is the space agency of India. The organisation is involved in utilising science, engineering and technology to harvest the benefits of outer space for India and mankind. ISRO with the satellite technology provides services in various fields such as communication and broadcasting, rural education, agriculture, rain-crop survey from satellite images, weather forecasting, natural disaster management, conservation and development of natural resources, border security control, telemedicine and many more. For the purpose of public service, national security and the country's overall development, ISRO is providing advanced

services by designing various satellites and technology.

Alongside its technological advancement, ISRO contributes to scientific development, awareness and research in the country. ISRO's own Lunar and interplanetary missions along with other scientific projects encourage and promote science education, apart from providing valuable data to the scientific community which in turn enriches science. Also, by undertaking challenging scientific projects like exploration of outer space, outer-planets and achieving good results, ISRO has made its glorious presence felt at the International level.

Dr. Vikram Sarabhai, the Father of Indian Space Programme, (Fig-1) kick-started the Space sector projects in India,

which was a developing country. It was hisdream that space-based projects should help in the welfare of mankind, development of the country and it should be put to peaceful use. It was under his leadership that the Indian space Agency got established on August 15, 1969, under the Indian Department of Atomic Energy. After Sarabhai's untimelydeath, Prof. Satish Dhawan led India's space sector and showcased its amazingachievements to the whole world.

Fig-1- Dr. Vikram Sarabhai

2. Prof. Satish Dhawan's Childhood & Education:

Prof. Satish Dhawan was born on September 25, 1920 as the second son of Devidayal Dhawan and Lakshmi Khosla ((Fig-2). Prof. Satish Dhawan's father Devidayal Dhawan started his career as a lawyer in the pre-independent Punjab province and was later promoted as a judge in the Lahore High Court. Satish Dhawan's grandfather Dhunichand Khosla (maternal grandfather) was the Chief Health Officer of Kashmir province and provided good health care to the common people. He was popular during the plague epidemic in the 1900s for his selfless service. Born in such a family, Satish Dhawan was instilled with a humble character from a young age. He used to respect elders and loved the younger ones

right from his childhood. He was also smart in play and lessons.

Fig-2: Devidayal Dhawan, Lakshmi Khosla

Devidayal's profession required him to travel to different cities and towns, so Satish's childhood education was provided by private teachers at home. He passed Matriculation (1934) and Intermediate (Science) Examination in Ludhiana. When Devidayal was transferred to Lahore, Satish

graduated with a BA in Mathematics and Physics from Government College, Lahore. Due to the British rule in India, English proficiency was required for any opportunity, so he earned M.A. degree in English literature (1941). Not satisfied with B.A. and M.A. degrees, he joined the McLagan College of Engineering at Lahore, topping the entire university and becoming the province's first gold medallist.

Later, Satish Dhawan joined the aeronautical department of the Hindustan Aeronautics Limited (HAL) in Bengaluru for a one-year (1944-45) internship and engaged in the assembly and repair of warplanes. The engineering education he acquired and the internship at HAL made Dhawan interested in the field of aviation. In 1945, he went to the United States of

America for further studies under the government scholarship. Since it was the days after the second world war, academic classes in the aerospace department of Caltech University had not started. Ultimately, he joined the aeronautical department of the University of Minnesota, Minneapolis, and earned a Master's degree in Aeronautical Engineering after a year of continuous study. While there, he visited second-hand bookstores in his spare time, observed and read all kinds of books, and developed his taste in the world of literature. Later in 1947, Satish Dhawan (Fig-3) completed his doctoral studies at the Gallicton Study Center under the guidance of Hans W. Lippmen.

3. Entry to Indian Institute of Science, Bengaluru

Satish Dhawan returned to India in 1951 and joined the Indian Institute of Science (IISc) in Bengaluru as a Senior Scientific Officer. His interest in teaching, his ability to teach in a such a way that students could understand and his knowledge of the subject soon promoted

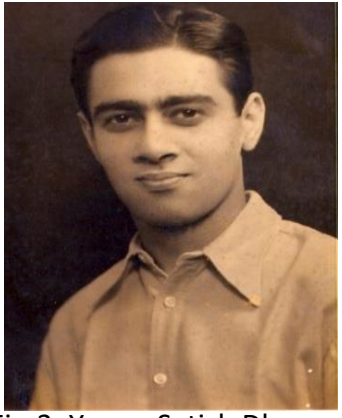


Fig-3: Young Satish Dhawan

him to the post of Assistant Professor. In 1955, he became the head of the Aeronautical Department. Prof. Dhawan used to read the topics andteach in depth, prepare notes, explain them with pictures, maps and figures. After each lesson, he would give a list of articles for reference for more and more practice. He also explained complex topics step by step in simple language. He used to read the essays written by students and correct them if there were any mistakes. The handsome Satish Dhawan dressed in attractive coloured clothes, rushing to the classroom through the stairs of the department, used to fill everyone's mind with enthusiasm and spirit. He used to wish everyone good morning. There was no esteem, pride or pomp in his appearance. Satish soon

became a favourite teacher among the students.

Prof. Dhawan was passionately involved in research and teaching. At IISc, Dhawan designed all the necessary equipment for his studies and equipped his own laboratory. Prof Satish Dhawan is credited with building the first supersonic wind tunnel at the Indian Institute of Science. (Wind tunnel is a large tube through which we can send air at the desired speed, simulate the vibration environment, test its effect on standard models like aircraft etc. Wind tunnels are also used to test the situations experienced by rockets in actual flight conditions). Satish Dhawan's focus of research was fluid dynamicsand also he is also known as the **Father of fluid science research in India.**

Satish Dhawan married Nalini in 1956 (Fig 4) who was native to Karnataka. She was awarded doctoral degree in cytogenetics from Washington University, St. Louis.

Fig-4: Prof Satish Dhawan and Smt Nalini Dhawan

At the age of 42 Prof. Satish Dhawan took over as the Director of the Indian Institute of Science, Bengaluru in 1962.

He faced many difficulties when he became a Director at that young age. It was Homi Bhabha's encouragement and advice that made him continue as the Director. Further, he led the Indian Institute of Science for about 20 years (1963-1981) into its glory. Prof. Satish Dhawan was the first to hold such a high position at a young age and also for such a long tenure.

Prof. Dhawan brought new changes to the activities at IISc. According to the

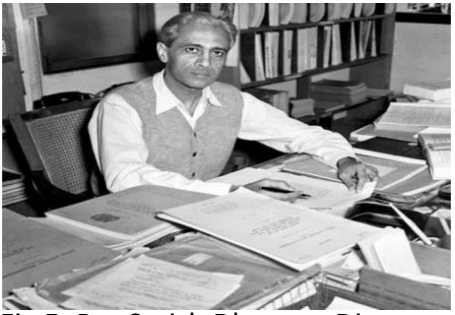


Fig 5: Pro Satish Dhawan, Director, Indian Institute of Science

contemporary field of science, Dhawan brought significant changes for overall development of the institution. Initially IISc started with only two departments. Prof. Dhawan started many new departments and research activities, brought skilled researchers into the institution for lectures

and also invited talented professors and scientists to join in the institute.

After Satish Dhawan took over as Director, he started several departments like that of Applied Mathematics, Materials Science, Biophysics etc. Since there were no departments related to basic subjects like pure mathematics, theoretical physics, atmospheric science, computer science, molecular biology etc., Satish Dhawan took special initiative and started them. Instead of department heads, a Chairman was appointed for each department. He introduced a system where the chairman post was available to all professors and faculty in rotation. Dhawan's monumental efforts made Indian Institute of Science an organization of great repute at the International level.

4. Entry to Indian Space Research Organization

During 1971-72, Dhawan was the Director at Indian Institute of Science and also a Visiting Professor at Institute of Technology, California, USA. The scientific community in India proposed and nominated Prof Satish Dhawan for the position which lay vacant by the untimely death of Dr. Vikram Sarabhai, who founded the Space Organization in India.

Prime Minister Indira Gandhi requested him to return to India and take charge as the Chairman of the Indian Space Research Organisation. Prior to this, Satish Dhawan had refused various offers, when asked to take charge of some of the country's leading scientific institutions.

Before he could shoulder the new responsibility of taking charge of ISRO, Prof Dhawan put forwardtwo conditions to the government. First, he should continue as the Director of the Indian Institute of Science and second, the Indian Space Research Organization should be based in Bengaluru, with only a nominal salary of one rupee per month (as he was paid as the Director of Indian Institute of Science).

After his returning from America, Prof.Dhawan took over the responsibility as the Chairman of ISRO and Director of IISc.

Prof. Dhawan's vision was that, if India's space organization headquarters was in Bangalore, the technical capacity and expertise of IISc, NAL, HAL, BEL factories could be utilized for satellite construction effectively.

5. Establishment of ISRO Centers

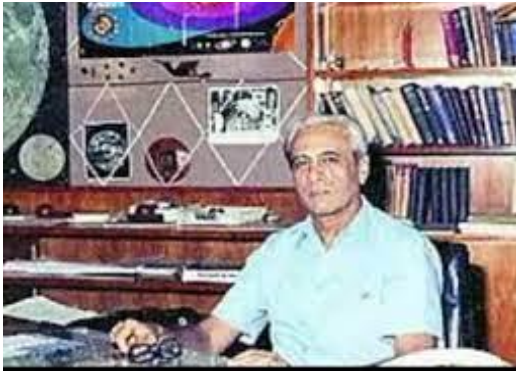


Fig-6: Prof. Satish Dhawan, Chairman, ISRO

In the past, ISRO was under the umbrella of the then Department of Atomic Energy and the Physical Research Laboratory.

Its cooperative units were functioning at Ahmedabad, Thiruvananthapuram and Sriharikota.

Prof. Dhawan set up a systematic administrative structure to give more responsibilities to Indian Space Research Organization. He established a new "**Department of Space**" under the central government and also established a "**Space Commission**" with scientists, engineers and administrators as members. He also planned to make the three different organizations of ISRO in different places to work in coordination. The Space Commission was meant to formulate India's long-term space plans. The Department of Space, along with the Government of India, was responsible for providing the necessary facilities, privileges and finances for the

projects. ISRO was responsible for implementing the space projects in cooperation with Space Commission and Department of Space. Prof. Satish Dhawan also held the responsibility of Secretary of the Department of Space, Space Commission in addition to being Chairman of ISRO (Figure-6).

Dr. Vikram Sarabhai's dream was to build satellites in India and put them into orbit from India. To implement the plans in that regard, Prof. Dhawan established various centres based on satellites, rockets and their uses and appointed directors for centres who could take them on a development path.

- He renamed the Center for Space Science and Technology, Thiruvananthapuram as **Vikram**

Sarabhai Space Centre (VSSC), appointed Dr Brahma Prakash as the Director, and initiated rocket development.

- Prof. U R Rao was made Director of the Satellite **Centre in Bengaluru** and was entrusted with building satellites.
- He established the **Space Application Center (SAC)**at Ahmedabad and appointed Prof. Yash Pal as the founding director.
- During Dr. Vikram Sarabhai's tenure, Sriharikota, an island, had been identified and designated for rocket launching. Prof Satish Dhawan developed a systematic rocket launching centre in stages without losing focus on preserving nature and

the original inhabitants there, the 'Yanadi' tribe.

Dhawan's role in ISRO Launch Vehicles: Another jewel in his crown of achievements was the realization of Satellite Launch Vehicle. Under his leadership and guidance, the project was to build and launch India's

Fig 7: Prof Satish Dhawan with other scientists

first Satellite Launch Vehicle (SLV) was intitiated. The entire responsibility of SLV project was assigned to Dr. Abdul Kalam. SLV was launched from the Sriharikota launch pad. SLV project failed due to faults in the control system of the second stage in the vehicle.

Prof. Satish Dhawan showcased his true leadership skills during the failure, where he faced the media with a calm demeanor and answered all their questions. Later, the team identified the problem in the launch vehicle and proceeded to rectify it. His ability to manage the focus of the team and handle the technical and social impact in a tactful manner helped the project staff correct the issues and the SLV-3 rocket was successfully launched again on July 18, 1980. With this success, India joined

the prestigious group of nations with the capability to build launch vehicles. When Dhawan was surrounded by media/journalists, Abdul Kalam was instructed to hold a press conference with the team members. **It was Satish Dhawan's belief that the leader should give credit to the team for the success of the workand when setbacks occur, the leader should accept the responsibility for all failures and protect his teammates.**

An attempt to upgrade SLV-3, successfully led to the construction of a rocket called ASLV. At the same time, plans for design of satellite carriers like PSLV and GSLV were underway. PSLV (Polar Satellite Launch Vehicle) was a powerful rocket capable of launching 100 kg sensor satellites into fixed orbit. GSLVs (Geo Stationary

Launch Vehicle) were capable of launching communication satellites weighing up to 1500 kg. Prof. Dhawan was the key designer in the original structure of PSLV. PSLV soon became the workhorse of ISRO, serving as the basis for all future space projects of ISRO.

6. New Chapter–Experimental Satellites:

A visionary of the future, Prof Dhawan was convinced that if India could build and launch high-capacity satellites independently, it could help the rapid development of the country. India's first Satellite-Aryabhata named after the famous astronomer and mathematician was designed and realized under the leadership of Dhawan.This satellite was successfully launched by a Soviet Union rocket on April

19, 1975. This started a new chapter in India's indigenous satellite technology.

Prof. Dhawan formulated the following plans to give a clear shape to the

fig 8: Prof Satish Dhawan & Prof U R Rao

satellite projects and to implement them so that the organization would grow at a faster pace.

- **SITE Project** (Satellite Instructional Television Experiment) was developed during 1975-76, with the help of American ATS-6 satellite. Television educational program was telecasted for 4 hours a day to villages in 6 states of India. This SITE program eventually led to the creation of the INSAT series of satellites.
- ISRO and Department of Posts and Telegraphs jointly prepared the **STEP project (Satellite Telecommunication Experiment Project)**. In 1977-79 the Franco-German Symphony was used for practical daily communications by satellite.

- Next in line was a small, experimental satellite called **APPLE,** which was successfully launched by the European Space Agency's Ariane launch vehicle.
- India's second satellite **'Bhaskara-1**' was experimentally placed into the fixed orbit on June 7, 1979 for Earth observation.
- On 18 July 1980, India's third satellite '**Rohini**' was successfully launched under the second experimental launch of the SLV-3 rocket. This was followed by a series of successes as follows.
- **Launch of RSD-1 of SLV-3 Rohiniseries** (May 31, 1981)
- **Launch of Bhaskara-2** (November 20, 1981)

- **Launch of INSAT-1A** (April 10, 1982)
- **Launch of RS-D-2 of SLV-3 Rohini series** (April 17, 1985)
- **Launch of INSAT-1B** (August 30, 1983)

7. Prof. Satish Dhawan –Administrator, Mentor

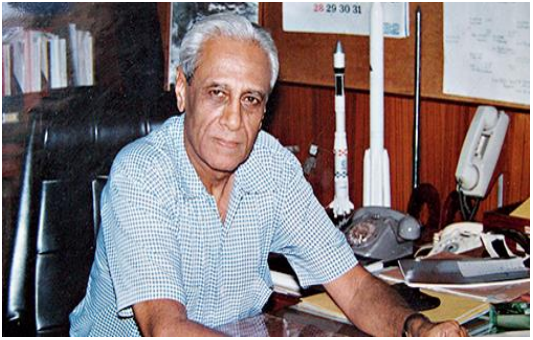


Fig-9: Prof Satish Dhawan

Prof Satish Dhawan believed that if everyone would interact and consult together, the decisions and results that came out were better. During the 10 years of Prof. Satish Dhawan's chairmanship, India's space program saw extraordinary growth and success.

Prof Dhawan did not chair any other management committees except when he was the Chairman of India's first satellite 'Aryabhata' Planning Committee. Skilled and knowledgeable scientists were appointed to the planning committee and Project director of the committee was responsibile for taking decisions about the project. Every senior and junior technician who is part of the project could participate in the review meetings and ask questions or doubts.

During the period, when space technology was being developed and pioneered at ISRO, IISc was not overlooked. He carried out many activities there too. Prof. Satish Dhawan used to head the governing bodies of scientific centres like Raman Research Institute, HAL, NAL, and guided them in aeronautics.

Prof. Satish Dhawan retired from the Indian Institute of Science in 1981. In 1984, he handed over ISRO'S chairmanship to Prof. U.R. Rao as his successor and retired from the post of Chairman, ISRO. Even after retirement, he visited ISRO headquarters every day and provided guidance (Figure-9).

Prof. Satish Dhawan had two main goals in research. First, the content of the research topic. Second, research should be a beacon for technological development. He

was of the opinion that research should not only be for the sake of research but should also help in the development of human society.

Satish Dhawan did not like unnecessary praise. He was full of empathy and could feel for the hardships of others. He also cared for the poor and needy and stood for them.

Satish Dhawan's had great love was for children. He used to go to government schools, join with children and provide whatever services he could do for them.

Images of memorable events of Prof. Satish Dhawan's life are shown in Figures-10 to 25.

Fig-10: During visit to ISRO centre

Fig-11:During visit of Prime Minister Moraji Desai

Fig-12:During visit of President K R Narayanan

Fig-13:During visit of President Fakruddin Ali Ahmed

Fig-14:Prof Satish Dhawan with Dr. Manmohan Singh during his visit

Fig-15:Prof Satish Dhawan with Prime minister Smt. Indira Gandhi during SLV successful launch

Fig-16: During visit of Prime minister, Smt. Indira Ganthi, Prof. Satish Dhawan, Prof. U R Rao, Dr. K Kasturirangan

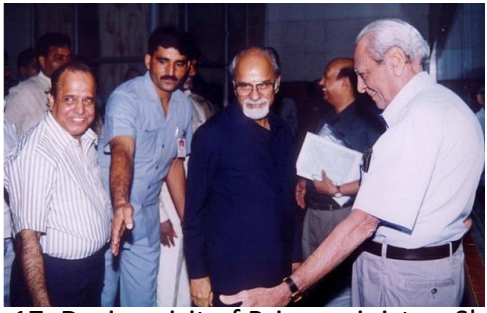


Fig-17: During visit of Prime minister, Shri I K Gujral, Prof. Satish Dhawan, Prof U R Rao, Dr. K Kasturirangan

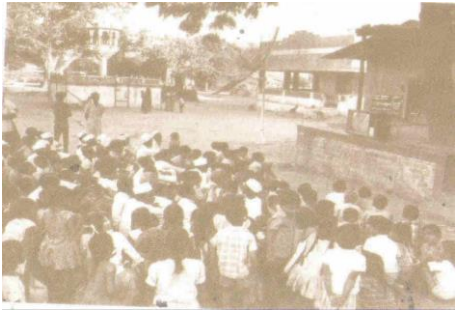
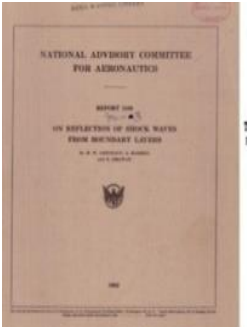


Fig-18: Villagers viewing TV through SITE project



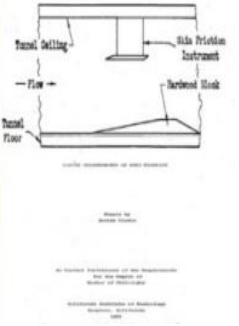


Fig-19: Prof. Satish Dhawan's research

Fig-20: Prof. Satish Dhawan with 1st launch vehicle project team

Love for Environment: Prof. Satish Dhawan was fond of nature. He took special efforts to develop the launch pad infrastructure at Sriharikota without any harm to the natural environment, as a result of which, ISRO has built a world-class space launch centrethere. Prof. Dhawan used to immerse himself in the environment of Sriharikota whenever he got time. At Sriharikota, he used to spend a lot of time observing the

scenery and capturing pictures near Pulikat Lake and Nellapattu Bird Sanctuary. Inspired by this, he wrote a book called "**Birds in Flight**".

8. Awards, Honours:

In recognition of his contribution, Prof. Satish Dhawan was felicitated by organizations from various countries. Many universities awarded honorary doctorates. Honors are numerous, the most important are:

- Padma Bhushan (1971),
- Padma Vibhushan (1981),
- Karnataka Rajyotsava Award (1984),
- Indira Gandhi Award for National Integration (1999)

- Distinguished Alumni Award from Indian Institute of Science and California Institute of Technology

Fig 21: Prof. Satish Dhawan receiving Padma Award

Twinkling Star: Prof. Satish Dhawan, who started his career as a teacher and led two outstanding institutionsleft this world on January 3, 2002 at the age of 82 and became a shining star in the sky. It was Prof.

Satish Dhawan, who made Dr. Vikram Sarabhai's dream come true and made ISRO shine at the International level. To honor his contributions, ISRO's Sriharikota launch centre was named as **Satish Dhawan Space Centre** (Fig-22) on September 5, 2002 ie on Teachers' Day.

Fig-22: Satish Dhawan Space Centre

At Karnataka Science and Technology Council, a medal, cash and

award in the name of Prof. Satish Dhawan was constituted.

When the Indian Institute of Science celebrated its centenary in 2009, postage stamps were released with portraits of the achievers who had contributed to the institution's hundred years of success. The postage stamp with Prof. Satish Dhawan stood out in the collection released. (Figure-

Fig-23: Postal stamp

23).

9. Conclusion

Dr. Vikram Sarabhai, the Father of Indian space science, initiated the space program in India and dedicated it to serve for India's national security and all-round development. Prof Satish Dhawan's role was remarkable in taking ISRO to an International level. In addition to being an extraordinary intellect, he was an efficient administrator, a valiant leader, a fearless upholder of principles and values. Overall, Prof. Satish Dhawan was the perfect amalgamation of a true teacher, scientist, inventor, thinker and mentor.

Fig-24: Prof Satish Dhawan inspecting technology

Fig-25: Prof Satish Dhawan inspecting technology

READER'S NOTES

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   by Ananda S
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   by Priyanka V
4. Prof. Satish Dhawan
   (Teacher, Scientist, Researcher,
   Thinker, Guide)
   by Prasad BS
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Shri Prasad B S, has been working Since 2005, at Library &Documentation Division (LDD) at U R Rao Satellite Centre, Bengaluru. He is involved in user-assistance services in retrieving& providingdocuments/ information related to space and satellite technology. His areas of interest includes library computerization, modernization & digitization, information management, electronic resources management and IT for all basic services of library.

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