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ORIGINAL PAPER

Satellite Instructional Television Experiment (SITE): a case study in the triumphs and frustrations of state-sponsored science in India

Pranav Sharma[1]

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Abstract
Satellite Instructional Television Experiment (SITE) was an experiment rooted in the philosophy of Nehruvian socialist science, Vikram Sarabhai's leapfrogging vision, and the Indian scientific community's dedication to the development of the county. It was designed and executed for educating and connecting the people of the country. Yash Pal, the figure of modern scientific education in India, played a crucial role to realize this dream project. Though SITE was not entirely successful in fulfilling its role, it did lay foundations for a bigger space science objective for education. In this essay, I explore the progress of socialist science and its impact on major scientific developmental projects through the SITE. It also takes into account several oral history anecdotes from the interactions I had with Yash Pal and his colleagues over several years.

Keywords ATS-6 · Educational satellite · Krishi Darshan · Nehruvian science · SITE · Satellite communication · Satellite television · Television broadcasting · Yash Pal

1 Science and India: hopes and struggles

The world had just suffered the whips and scorns of the Second World War. It had become crucial for the post-war world to focus on development. Robert Oppenheimer was a fallen God now (Bird & Sherwin, 2005). Even though the world was not ready for science to take over its civilizational course (given that it had recently saw inhuman and disastrous use of science), but it was clear that it would be impossible to run the developmental nation-building programs independent of it. While Europe and America were struggling with post-war ideological conflicts with the absurdity of a necessary demon called science, India was emerging as a free country but with shackles of complex problems. She was born in an unstable geopolitical scenario and the horrors of communal violence. According to Chugtai (2001, pp. 3–5) "Communal violence and freedom became so muddled that it was difficult to distinguish between the two". It was important for India to neutralize the conflict before the plans for progress and prosperity of the country could be imagined.

Jawaharlal Nehru, the first prime minister of independent India, was greatly influenced by eighteenth-century European Enlightenment and emerged as an avowed, uncompromising, and self-proclaimed rationalist (Mathur, 1990). To transform India, he had to get several discursive frameworks in order, and then align them in a way that they lead to a common goal. In the 1937 session of the Indian Science Congress in Hyderabad, Nehru posed science as a solution to all major problems of the county, and science alone could do so. Nehru attempted to run his government and the developmental enterprise on the principles of science and reason (Fig. 1).

In his seminal work, Nehru elaborated his vision:

> [What is needed] is the scientific approach, the adventurous and yet critical temper of science, the search for truth and new knowledge, the refusal to accept anything without testing and trial, the capacity to change previous conclusions in the face of new evidence, the reliance on observed fact and not on pre-conceived theory, the hard discipline of the mind—all this is necessary, not merely for the application of science but for life itself and the solution of its many problems (Nehru, 1946).

Nehru's work "largely" focused on "trying to make the Indian people and even the Government of India conscious

✉ Pranav Sharma
quantumpranav@gmail.com

[1] Science Historian, Independent, New Delhi, India

Fig. 1 Jawaharlal Nehru addressing the 43rd session of Indian the Indian Science Congress at Agra on 2nd January, 1956 (Dadhich, 2016) (In Agra, Nehru emphasised ".. the problems that the Indian scientists had to deal with were related to the development of better standards of living, removal of economic in-equalities and so on and so forth" And "This is why the men and women of science should consider the basic approach to problems, I mean the temper of science, the temper of reasonableness, the temper of peace. These approaches are very important to end and solve the problems facing them" [Ashok Parthasarathi and Baldey Singh, *Economic and Political Weekly*, Vol. 27, No. 35 (Aug. 29, 1992), pp. 1852–1858].)

of scientific work and the necessity for it" (Singh, 1986, p. 20). The impact of his thought on the will of 'his people' and 'his government' declined over time[1] and Nehru found himself frustrated by the 'bureaucratization' of his vision. In the later years of Nehru's government and the governments after him, did try to build India with a hazy dream of science in their eyes. They were neither ready nor equipped to sustain the challenges of tradition and superstitions, and there were times when their efforts proved counterproductive. The Indian Science Congress met in Delhi in 1963 to celebrate its Golden Jubilee year under the Presidentship of Daulat Singh Kothari.[2] During his address, Nehru expressed his deep frustration with scientific enterprise succumbing to 'governmental way' (Morehouse, 1969).

In 1947, when India gained its independence, Nehru also got elected as the General President of the Indian Science Congress, a non-scientist at the helm of a scientific body. Science was Nehru's nationalist program for development to overcome the contingent of the Indian *backwardness*. It was a state-sponsored socialist enterprise. Even though India became independent in 1947, the hangover of her colonial past still continued to haunt the country. Therefore, it fell upon the educated classes to uplift the poor and enlighten them. It was not the first time the elite took charge. Gyan Prakash (1999) argued that whilst colonial science came to India as a cultural civilizational mission thereby establishing European supremacy, but as Western science propagated in India, the more it proved counterproductive for the colonial masters. The colonial science, he argues turned against the colonizer by the Indian elite who used this knowledge to counter British imperialism. However, he also points out that the difference between the colonial project and the nationalist scientific enterprise was quite flimsy. This little to no difference continued to exist.

In his later years, Nehru had a constant internal struggle. His India was disintegrating and so was his science. He still kept on using his declining influence for the upkeep of his dream of a scientific nation. Nehru breathed his last on 27 May 1964 with a deep debt of gratitude for his colleagues, with whom he shared triumphs and sorrows which inevitably accompany them.[3] Nehru, knowing the extent of the luxury of thought India could afford, and with his affection for science, was entirely not of an opinion that science could hold a monopoly over truth (Arnold, 2013). He believed that science could solve major developmental problems of the country and its people. The Second Five Year Plan (1956–1961) focused on the rapid industrialization of India.

Bewildered by the haste to achieve everything in one lifetime, he allowed himself to be consumed entirely by the 'system'. It would be an act of misjudgment if one imagines Nehru to be doing the right thing all the time. He did the right thing mostly but he also resorted to quick fixes. Despite reservations, Nehru and his scientific allies like Homi Bhabha, Vikram Sarabhai, and Shanti Swaroop Bhatnagar knew that India required international expertise to modernize herself. They were internationalists who understood the strength and capabilities of collaboration and India needed just that. She had virtually no resources of her own. Science in Nehru's regime became a state dictated enterprise. It was a means for the state to run the socio-cultural transformation machinery and we would see how it divulged from its cause later. Its franchise was only limited to a select group of experts who were working in the top-down structure of governance which proved to be fatal at several junctures.

Vikram Sarabhai (who later established the Indian Space Research Organization) had (as he famously called it) a *leapfrogging* vision for India. He believed that the only way for India to catch up with the developed world was to bypass the usual stages of the process by exploiting ultra-modern

[1] His thought was reviewed in the context of Indian democracy but not to an extent of making a broader case for it.

[2] He was the Chairperson of the National Education Commission constituted by Nehru just before his death.

[3] Jawaharlal Nehru's Will and Testament on Religion and Disposal of Ashes, Press Information Bureau of India—Archive. 3 June 1964.

technology.[4] The Atomic Energy Act of 1948 not only formalized nuclear research in India but also opened a vast avenue for unequivocal scientific institution building. Scientists like Homi Jehangir Bhabha (with whom Nehru shared a close friendship), C.V. Raman, Meghnad Saha, and their students and colleagues were working together in the field. It was not only a duty towards the country but also essential for national development. Sarabhai founded the Physical Research Laboratory in Ahmedabad as a niche cosmic ray research centre in 1947, and Shanti Swaroop Bhatnagar successfully established the Council of Scientific and Industrial Research that began its autonomous operations in 1948. The space-age began in 1957. It was the serendipitous juncture for Nehru to put forth the Science Policy Resolution. The parliament approved it in 1958. It was a stepping stone at the beginning of scientific institution-building and robust science policy in India. In the same year, the International Council of Scientific Unions had established the Committee for Space Research (COSPAR). In this dense environment of scientific institution building, Sarabhai who had established himself as a pioneering cosmic ray physicist began discussing a potential space program.

Bhabha and Sarabhai were able to convince the scientific community that India needs to leapfrog into the space age by having its space program. They already had the necessary political strength to go forward.

In 1960, COSPAR held its first space science symposium in Nice, France. Jacques Blamont, a professor at the University of Paris had recently initiated the French Space Program (Centre National d'Études Spatiales). He met Praful Bhavsar (who would later become the project director of the sounding rocket program) at the University of Minnesota during his visit. Bhavsar was a post-doctoral student there and had previously worked at Physical Research Laboratory in Ahmedabad with Sarabhai. He initiated a discussion with Blamont about the idea of an Indian Space Program and how Sarabhai envisioned it. Blamont was thrilled. They met in Nice during the symposium and then again formally at the Fifth General Assembly of COSPAR in Washington, DC. It was the year 1962.

A year before that, in 1961, the Department of Atomic Energy (chaired by Bhabha) took space research and peaceful use of outer space under its purview. It facilitated Sarabhai to establish the Indian National Committee for Space Research (INCOSPAR). With the launch of the Nike Apache sounding rocket, the Indian Space Program began on 21 November 1963.

Fig. 2 Prime Minister Indira Gandhi with President Johnson at the White House, March 28, 1966. (Wikimedia Commons)

2 Turbulence and opportunity

Sarabhai was inspired to use science to transform society by generating new forms of technology for the native. I am of the opinion that the real breakthrough in Space came with Television. These were very bulky, mostly complicated box sets that took an entire family to operate. The television broadcast was made possible with the help of satellites.

In the middle of a progressing nuclear program, Homi Bhabha died in 1966. Sarabhai took over the Department of Atomic Energy (DAE), and Indira Gandhi was sworn in as the Prime Minister. It was the same year that India had suffered a tremendous setback in agricultural produce.

The food situation continued to pose severe problems since rains again failed in 1966. Production of food grains (including pulses), which fell to 72 million tons in 1965, was estimated only 73–75 million tons in 1966, in comparison with the 88 million tons needed to feed the population.[5] India was receiving PL-480 wheat under Food for Peace program from the United States. It was a ship to mouth program because of critical famine conditions in India. The import of PL-480 had touched ten million tons. President Lyndon Johnson[6] started using US-AID as leverage for his foreign policy goals to seek 'assurance that the Indian Government would implement agricultural reforms and temper criticism of U.S. policy regarding Vietnam'.[7] It was making Indira Gandhi worried (Fig. 2).

'The assurance' from the Indian government was being tested at the Indian Agricultural Research Institute (IARI) in New Delhi. M.S. Swaminathan was working on a 'yield

[4] Our national goals involve leapfrogging from a state of economic backwardness and social disabilities, attempting to achieve in a few decades a change that has historically taken centuries in other lands (Convocation Address, Indian Institute of Management–Ahmedabad, April 1967).

[5] The State of Food and Agriculture 1967, *Food And Agriculture Organization of the United Nations*, Rome, 1967.

[6] 36th President of the United States (1963–1969).

[7] https://history.state.gov/milestones/1961-1968/pl-480.

revolution in wheat' that led to the famous *Green Revolution* in India. The challenge was to educate farmers to use this high yielding variety of seed. The answer to that came in the form of *Krishi Darshan* that started broadcasting on 26 January 1967.

One can audaciously say that these scientists had ambition for India. Yash Pal, a cosmic ray physicist (who would later become the director of the Space Applications Center) had returned from MIT where he worked with Bruno Rossi, was working at TIFR. In one of the conversations about Satellite Instructional Television Experiment (SITE), Yash Pal jovially reminisced (that I found contributed by him to an anthology of essays edited by P.V. Manoranjan Rao much later. I quote the excerpt from the essay here), he called this romance of the past[8]:

> I remember having conversations with him [Sarabhai]. He was 5–6 years older than me and he said, 'Yash, you could broadcast signals from very high up, and we could reach the whole of the country; and we could broadcast radio and TV programs to the whole country!' I said, 'What TV programs? We don't even have a television in our country.' He said, 'That does not matter; we will develop it. We will learn how to do this.' And then this man, Sarabhai, goes to Prime Minister Mrs Gandhi and says, 'We want to test whether space could be used for such purposes.' She says, 'But where are your rockets and how can you test?' He says, 'I have friends; we have scientific friends in America, everywhere, and so on. Let's see what we can do.' Sure enough, it was possible to persuade the Americans to move one of their experimental satellites, with a transponder for beaming TV programs, a little closer to India so that we can send TV programs up and they can come all over the country. But then who receives it in the country? What do you want to do with it? There is no television in this country. No television at all! And Sarabhai tells Mrs Gandhi, 'No, we don't want to put television sets in the cities. We will put them in thousands of unreachable villages. [An] entirely new thing to be done! We will engage with our country, we can engage with the people in our country much faster than we can do any other way.[9]

3 Setting the stage

Krishi Darshan served the purpose of preparation for the SITE. Upon insistence from Sarabhai, this exercise was taken up to understand project execution constraints and social and organizational behaviour. The project was conducted like an experiment with controlled variables. Statistical analysis was performed on the variables to understand the effectiveness of adult education. Imagine the sight: agricultural scientists dressed in traditional clothes and educating farmers about modern-day agricultural practice. The 'set' comprised of education and entertainment, an interesting balancing act.

'The overwhelming orientation of this program was towards *the top-down flow* of experts' advice by the way of 'informing' and 'educating' the farmers about increasing agricultural productivity' (Sinha, 2009, p.135). The idea of television broadcasting was not new to the power alleys of South Block. Suggested for the first time in 1951 by the Government's Scientific Advisory Committee,[10] it did not gain much momentum because Nehru was not very motivated to commit limited resources of the government on the project because of its extensive budgetary requirements.

India became a testing ground for modern technologies. The government's commitment to technological advancement was evident even though they faced tremendous economic struggle. In the Industrial Exhibition organized in Delhi in 1959, Philips India was able to set up a demonstration unit of closed-circuit television. After much deliberation, twenty-one television sets along with a broadcasting transmitter were bought by the Government of India at a reduced cost. To support the Government of India in their endeavour UNESCO awarded a grant of $20,000. This support was used to purchase additional fifty-five television sets and a community viewing setup was made in Delhi and its peripheries.

When SITE was imagined, it was evident that the only properly functional broadcasting television station was in Delhi. It was working with news broadcasts and a few programs. *Krishi Darshan* was broadcasted in about eighty villages around Delhi because of limited resources.[11] It proved to be effective to a certain extent initially. Taking into

[8] I was in discussion with Yash Pal on a forum in Agra in 2012. In response to my comment on falling in love with science to actually enjoy it, he said if one is in love if there's something romantic about doing it, even a bit of a scandal, it increases the chances of it being done.

[9] Incidentally, I was present when the chapter contributed by Yash Pal to *From Fishing Hamlet to Red Planet: India's Space Journey* [Ed. P.V. Manoranjan Rao et al., Harper Collins, 2015] was recorded.

[10] I believe the government must have thought of investigating the matter after B. Sivakumaran, a student of electrical engineering at Central Polytechnic, Madras put up a cathode ray tube set and demonstrated its working by scanning a letter and projecting it on the screen.

[11] Television receivers were made by Central Electronics Engineering Research Institution (one channel & black-and-white television sets). The programs were primarily on new methods of agriculture transmitted by All India radio on Delhi television station.

account its progress, DAE got eight television sets funded lauding its 'effective' interdepartmental collaboration.

All India Radio (AIR) was responsible for the broadcast while IARI was producing necessary content for the program to be broadcasted twice a week. Yash Pal fondly told me one day, "…we were only working for the country that was our only goal. There were no disciplinary boundaries, all of us wanted to see India progress…" This progress led to something fascinating.

Several years later, Blamont (2015) wrote:

> …I had become a close friend of Vikram and now I regret that I could not give him much of my time. I do not remember at which time, around 1967, he took me one evening to a village, 50 kilometres from New Delhi. On the central esplanade, a television receiver placed on a scaffold was being watched by about 200 peasants trying to understand the images. Fortunately, the loudspeaker was good. An educative program was being broadcast by the national television organization in New Delhi. Coming back with Vikram in his car, we were not certain that the system had shown any efficiency, but it had great potential, as the later Indian space programs SITE, INSAT,[12] and EDUSAT[13] had proven…

Of course, Indira backed the SITE completely but rural development or education were not the only goals that were of interest to her. She sensed the power of mass communication that she misused during the Emergency years and her last regime in the early 1980s.

> A wit among media circles once observed that while Jawaharlal Nehru was a visionary, his daughter Indira Gandhi was a televisionary. The quip, of course, was a cruel, backhanded compliment to the authoritarian ways in which Indira Gandhi shrewdly manipulated Indian television to project her political image by using the state-sponsored network, Doordarshan, for what her critics derisively called "Indira Darshan" (Kumar, 2005).

This must not be held as a discursive argument against her. However authoritarian, Indira was indeed a visionary like her father. It was her initiative to establish a nationwide television network for which she chose Vikram Sarabhai to plan the development of television in India. It was then Sarabhai's famous 'Television for Development' came into the picture. This program was to provide television to about eighty per cent of India's population in the following decade. He envisioned it to of great significance to national integration, for implementing schemes of social and economic development, and for the stimulation and promotion of the electronics industry, contributing significantly to the sizeable population living in isolated communities far from the metropolis (Sarabhai, 1974a, 1974b).

Indira Gandhi was inspired by technology the tools of modernity were powerful. Nehru on the other hand was driven by the fundamental idea of scientific inquiry. Indira's excitement was intoxicating, so was Sarabhai's enthusiasm.

4 Cold war, 'noise' from Lop Nur, and Sarabhai's socialism

In the early 1960s, American scientists started discussing the technology of a geostationary satellite for telecommunication over a Lower Earth Orbit satellite. This change was still being debated for technical feasibility when Hughes Aerospace showed its confidence in making this possible. It was a great opportunity for John F. Kennedy to show the world that the US is committed to fulfilling the common good by involving developing in this 'single global network' and perhaps helping them make their own satellites.

This US-sponsored empowerment exercise was also to gain hold over the Afro-Asian countries. Much before Frutkin's call to Sarabhai, V. Pail, the chief engineer of Indian Overseas Telecom and Sarabhai discussed similar ideas with NASA. It also led to a space science symposium organized by Sarabhai in Ahmedabad in 1963 that focused on communication as an upcoming field of scientific interest and impressed upon the fact that India must participate in it.

On 16 October 1964, the Chinese successfully performed a nuclear test at Lop Nur in Xinjiang province that destabilized the geopolitics of Asia and created a new threat to the US. It was 'a major achievement of the Chinese people in their struggle to increase their national defence capability and oppose the U.S. imperialist policy of nuclear blackmail and nuclear threats'.[14] The propaganda condemning this act by the Chinese followed immediately after that.

Nehru lost to the Chinese in 1962. It had created unusual unrest in the Indian scientific community. Defence implications of scientific research took serious momentum, so much so that the sacrosanct Science Policy Resolution of 1958 was brought under review for its ambiguous and

[12] It is the short form for the Indian National Satellite System (INSAT) that are used primarily for telecommunication and broadcasting. It was commissioned in 1963.

[13] GSAT-3, launched on 20 September 2004 was India's first 'Educational Satellite' dedicated to distance classroom education (school & higher education).

[14] Statement of the Government of the People's Republic of China, October 16, 1964, History and Public Policy Program Digital Archive, PRC FMA 105-01262-01, 22–26. Obtained by Nicola, Leveringhaus. https://digitalarchive.wilsoncenter.org/document/134359.

underrepresentation of the use of science for defence and national security purposes.

The news of the Chinese nuclear test came in five months after Nehru's death. A very close friend to Nehru and his confidant, Homi Bhabha, was infuriated. Bhabha broadcasted the estimates of making a nuclear bomb underlying the importance of it to deter any attacks on India on the national radio soon after he got the news of the test (Anderson, 2010). It was now the media's job to take this further.

The U.S. got terrified by the news and wanted to discourage India to plan a nuclear test by giving them geosynchronous technology. This was the plan to direct funds away from the nuclear program and into the satellite technology. The U.S. wanted to help India re-establish its international scientific prestige and further India's scientific developmental goals. This followed several visits by Bhabha and Sarabhai to engage with the American academia and the government to gather support for science at home. Bhabha was frustrated by the dilemma of conducting science for 'peaceful purposes and the desire to give China a befitting response by conducting a nuclear test. This could be achieved, explained Bhabha in Washington DC, in eighteen months without any help. If the U.S. decided to support it, the same could be achieved in six months. The 'noise' from Lup Nur should be countered effectively. However, when the conversation with James Webb actually happened, Bhabha shifted to discussing India developing satellite orbiting capability.

Sarabhai was not convinced about using science for strategic purposes. He only saw science as a tool for socio-economic development and intellectual empowerment. He was a true Nehruvian socialist, perhaps a little more than Nehru himself. I believe that Nehru would have reluctantly given up and agreed with Bhabha if he were alive to witness this debacle. However, we never see any change in Sarabhai's narrative, he was truly dedicated to social reform through science. Sarabhai's idea for developing countries to leapfrog to advanced science and use the tools of the modern-day was also rooted in the imagination of narrowing the disparity between rich and poor countries. He strongly believed in self-reliance and that he does "not wish to acquire black boxes from abroad but to grow a national capability" (Sarabhai, 1974a, 1974b, p. Xiv).

It had become for India that if she wishes to have a rapid yet sustained national growth, she needs to employ the tools of mass communication urgently. The U.S. saw this as an opportunity to offset China's influence in the region by making India more empowered technologically and helping her connect with her rural population and working towards bringing literacy and development in these isolated regions.

It appeared as a win–win arrangement. Although scholars like Arthur C. Clarke were concerned about the political implications of the project. Clarke wrote:

> Living as I do in the Far East, I am constantly reminded of the struggle between the Western World and the USSR for the uncommitted millions of Asia… when the line of sight TV transmission becomes possible through satellites directly overhead, the propaganda effect may be decisive…the impact upon the peoples of Asia and Africa may be overwhelming. It may well determine whether Russian or English is the main language of the future. The TV satellite is mightier than the ICBM…[15]

5 Satellite instruction

The "greatest communications experiment in history" (Pal, 1977, p. 55), SITE was a massive social engineering experiment and perhaps the largest sociological experiment attempted at the time.

> SITE can be considered a pace-setter and fore-runner of satellite television systems particularly of those meant for development. It is an example of the technological and psychological emancipation of the developing world. Its most important element was the commitment and dedication of all people and organizations involved to the one overriding goal of rural development in India.[16]

In June 1968, the Indian Space Research Organization (ISRO) and U.S.'s National Aeronautics and Space Administration (NASA) came together in a joint commission with Wilbur Schram as its chairperson to evaluate how direct reception can be done using the ATS-6 satellite. It was possible because the satellite had a nine-meter large antenna and the necessary capability.

Leonard Jaffe was the director of the NASA satellite communications program. He was the engineer who designed and oversaw the deployment of NASA's Applications Test Satellite (ATS) series from ATS-1 to 6 as well as the Communications Technology Satellite.[17] It was this ATS-6 satellite that was for the SITE in India.

Arnold Frutkin, then director of NASA's Office of International Programs was approached by Jeffe for a TV broadcast program that could be done directly to the receiver on the ground to see if he would be interested. He was excited

[15] Next Ten Years in Space, 1959–1969, Staff Report of the Select Committee on Astronautics and Space Exploration, 85th Congress, 2nd session, p. 32.

[16] Report on the SITE Winter School, UN Document No. A/AC/105/177, United Nations Committee on the Peaceful Uses of Outer Space (December 2, 1976), p. 13.

[17] SP-4217 Beyond the Ionosphere, https://history.nasa.gov/SP-4217/sp4217.htm.

but the primary concern was to find out the best site for the project. After much deliberation, Brazil and India were shortlisted for the project. Brazil was fairly 'advanced' given the nature of the project, which meant they were exposed to television along the coastline. That would have been alright but the key concern of the team was the irregular distribution of the population in Brazil.

India, on the other hand, had its population distributed all over the subcontinent and television was virtually non-existent. Therefore, India qualified as the ideal candidate for the SITE. The plan for SITE in India was to direct the satellite into an equatorial orbit that would pass close to India (after having used the satellite for a year for American purposes). The ground station was to be set up by Indian scientists and broadcast educational programs. The purpose of the satellite was to diffuse them down to earth receivers.

Frutkin felt it right to contact the State Department. The person at the India desk was reluctant to do anything. His usual response was, "The Indian won't let you do that." He sensed that he was being stonewalled by bureaucratic machinery. Therefore, he decided to contact Sarabhai himself.[18]

> … I called Vikram Sarabhai and said, "Vikram, this is something we think you'd be interested in. Would you be interested in it?"
> "Of course. Yes." [said Sarabhai]
> So I said, "Write me a letter proposing Indian participation in the SITE program which is being prepared.[19]

Sarabhai wrote back immediately. Since India had proposed its participation, the State Dept. could not produce any objections. Recommendations were made to President Johnson by the task force and ATS-6 satellite was given to India with a one-year contract.

This NASA–ISRO collaboration was led by one of the finest men in the enterprise. Apart from Arnold Frutkin and Leonard Jaffe, the program was organized by the then Program Manager of SITE, J.E. Miller. Howard Galloway, the Resident Representative of Goddard Space Flight Centre, was Jaffe's insider in the project. On the Indian side, E.V. Chitnis was the overall Program Manager. Chitnis got the support of technologist Pramod Kale, who assumed the role of the project manager of SITE to supervise the development of electronics and TV hardware for the project. The Director of the Space Applications Center (SAC), Ahmedabad, Yash Pal was one of the key figures of the program. P. Krishnamoorthy was the Software Program Manager, and Binod C. Agrawal was involved as an anthropologist to conduct the sociological evaluation of SITE during and after its completion.

Meanwhile, in India National Study Group for Satellite Communications (NASCOM) was formed in 1968. It was an inter-departmental consortium with concerning ministries involved to decide the structure of the SITE program. Grand show of uplifting the uneducated and superstitious rural India began.

Sarabhai was an indispensable resource to the Indian scientific enterprise. I tend to think that he was the last of the Nehruvian scientists who shared the vision of Nehru for the scientific development of India and had the autonomy to run the enterprise without any procedural glitches. He had his struggles, but he also knew the right solutions at the right time. His one-time classmate was the Prime Minister, and his friends were leading all the major institutions, this network came in quite handy. The unfortunate demise of Sarabhai on 30 December 1971 came as a shock, it was also a devastating moment in the scientific history of India. He was at the helm of almost all crucial nation-building scientific programs, which, after his death was orphaned. SITE suffered a setback and the project stalled for some time. Sarabhai's long-time friend and colleague, Yash Pal became the saviour of the project and engrossed himself in making SITE a success story.

The United Nations Development Program (UNDP) funded low-powered transmitters, and a production studio was set up in Pij village of Kheda (Kaira),[20] a district in the state of Gujarat (Chitnis, 1982).[21] Its satellite earth station was at the Space Applications Center (SAC) in Ahmedabad. Yash Pal was at the helm of the project. In the subsequent phase, 651 television sets were distributed among the residents of 400 villages in a 35 km radius.[22] It was also an opportunity to create a communication laboratory for software development. In total 2400 television sets were distributed across India to run the program successfully.

Before the programs began, teams of Indian social scientists and engineers had visited more than 6000 villages to select the ones to receive SITE transmissions; an individual in each village had to be identified as TV-set caretaker, and a public site usually a school selected as the viewing centre, so that "weaker

[18] Sarabhai was the chairperson of ISRO and very active internationally. He had been successful in making India's Thumba Equatorial Rocket Launching Station, a United Nations site for the sounding rocket program.

[19] NASA Headquarters Oral History Project (Arnold W. Frutkin, Interviewed by Rebecca Wright, Washington, DC on 11 January 2002). https://historycollection.jsc.nasa.gov/JSCHistoryPortal/history/oral_histories/NASA_HQ/Administrators/FrutkinAW/FrutkinAW_1-11-02.htm.

[20] It was also the home of the largest dairy cooperative society, Amul (established in 1946). I believe it was chosen because the village was being studied, the scientists were already stationed there, and there was enough infrastructure to start a pilot project.

[21] Based on a video recorded talk at the 13th Asian Advertising Congress held in New Delhi from 27 September to 1 October 1982.

[22] https://www.thebetterindia.com/114540/kheda-communications-project-site-television-india-vikram-sarabhai.

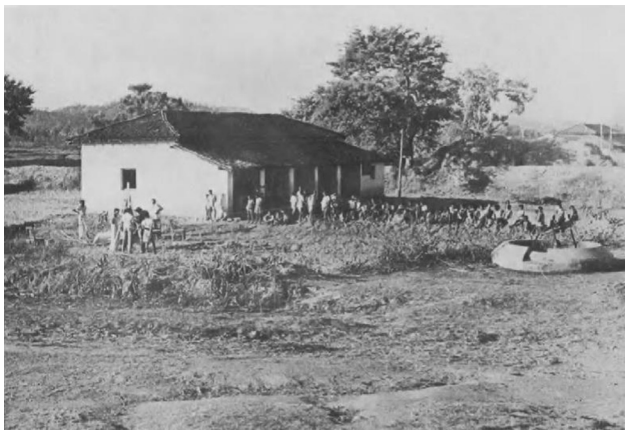

Fig. 3 Mostly SITE Centers were schools with just one room, catering to two or three classes and quite often a single teacher. The school teacher was usually the custodian for the installation. There was a half-hour programme every day for school children and two and half-hours in the evening for a mixed population of the village. (Pal, 1979)

sections of village society" could be assured of equal access to the TV programs. As some appropriate villages lacked electricity, these had to be supplied with power, a valuable side effect of the experiment. Programs for SITE had been developed by India's Ministry of Information and Broadcasting in collaboration with ISRO; program content and format had to be kept simple because of the high rate of adult illiteracy. More than 1200 h of diversified content were broadcast during the experiment; attendance was particularly high for programs related to animal husbandry and agriculture. Children's programs were received enthusiastically, with resulting improvement in school attendance, and many students brought younger members of the family to view the programs. One year of experimental TV would not "change the face of our villages," said Prof. Pal, but it had created "a cadre of dedicated people and the methodology necessary to sustain an ongoing program." As a follow-on, the Indian government would construct ground transmitters in six cluster areas of villages to include about 40% of those involved in SITE, to resume the educational programs by early 1977 (Ritchie, 1976) (Fig. 3).

The results of SITE were immediately visible, perhaps that's why the project captured Indira's attention. It helped increase attendance in schools considerably. The highlight of the project that no one anticipated was the electrification of numerous villages. It always amuses me to think how these bright scientists thought of using a television without detailing an electrification plan. Electricity is a prerequisite for setting a television receptions station![23]

Doordarshan took the plunge of making twelve hundred hours of instructional content. Those were, then, divided among SAC and Doordarshan due to lack of resources on the part of Doordarshan, with SAC utilizing the Kheda (Kaira) Communication System. First-generation television series were *Hajam* and *Chatur Mota*, followed by *Dhanji, Makenji*, and *Maliji* (named after three characters from *Chatur Mota*).

Pal (2015) remembers:

> It was pointed out to Sarabhai that there was no country with satellites broadcasting TV! He says, 'So what? We will learn.' …Then came the people who said, 'What are you talking about? You, physicists and engineers, learn to talk to the people of India? You sit in Delhi, you sit in Ahmedabad and you sit in Bangalore. What would you talk to the farmers of Bastar? What would you talk at various places?' We said. 'If it is so, we will have to learn to talk to farmers. Let us try to make it one country…

Chitnis called himself and his colleagues, a team of activists (Chitnis, 1982). They also engaged in investigative journalism programs on caste-based discrimination. The people who were engaged in making these educational & instructional programs were typically urban middle-class men with virtually no knowledge about rural India. The first batch of instructional material was far from what could be of any use in teaching in a village setting. They knew that it had failed terribly. Therefore, they started fieldwork.

David Arnold points out that '[Nehruvian science] was a program for sociocultural change, intended to transform society and prevalent mindset' (Arnold, 2013)). It was characteristically Nehruvian science, the way he could have imagined it. Nehru and Nehruvian scientists wanted science, scientific thinking, and a culture of inquiry to take over the imperial and 'orthodox' thought and practices that hold the country in its 'backwardness' (Morehouse, 1969). The civilizational mission was also a conversion mission.

The Memorandum of Understanding between DAE and NASA for the SITE program was signed on 18th September 1969.[24] Indian instructional objectives of the program were to improve agricultural practices, contribute to the governmental family planning goals, and national integration.[25] In

[23] World Wide Space Activities," Report Prepared for the Subcommittee on Space Science and Applications of the Committee on Science and Technology U.S. House of Representatives, Ninety-Fifth Congress, First Session (September 1977), p. 404.

[24] India-United States: Understanding Concerning Satellite Experiment Project for Instructional Television, *International Legal Material*, Vol. 8, No. 6, November 1969, pp. 1281–1287.

[25] Yash Pal told me that the thrill of sending a satellite in space that could facilitate communication and 'click pictures from space' was to enable the scientists and the government to 'see' the vastness of the country. This knowledge could help in policymaking and tailoring specific solutions for specific regions. "Suddenly we could talk to each other and space was our medium. It was fascinating!", he would say. [Private discussion, 2013].

addition to these, Sarabhai wanted the program to contribute to education, training of teachers, and health and hygiene education (Sarabhai, 1974a, 1974b). It was believed and later realized that 'television instruction can fulfil the key social role expected of it by India and by other developing countries' (Frutkin, 1970).

Frutkin (1970) says,

> [Actually this] (*SITE*) was a remarkable instance of how much in the U.S. interests such a program [can be], because India had one year, under our agreement, one year that they could use that satellite. They built their ground station. They broadcast their own programs, which they designed and which we watched very carefully when they were being developed because we wanted to be sure that they weren't going to do anything that would upset America for any reason. No political criticisms, no political news programs. There were wonderful [educational] programs which I could tell you about sometime, not [to] take the tape [now] for that, but [there] were some wonderful things.

Apart from the developmental objectives of the program, the partnering countries were also looking at the operational feasibility of using satellites in developed and less-developed countries about broadcasting strategy, satellite communication, and of course education. The results were then utilized for redefining the policy framework (Polcyn, 1972).

The Indian scientific community and bureaucracy were able to convince political leaders that having India's satellite communication system would help achieve these national 'developmental goals' and hence INSAT and EDUSAT programs were launched. This was India's 'window to the outside world to help change the whole system of education' (Singleton et al., 1975).

The examination system in India was surviving on the student's ability to 'cram from notes taken in the classroom'. To counter this, the Indian Association for Programmed Learning believed that programmed material would help students develop a self-study habit (Kulkarni, 1969). This 'developmental television' was supposed to serve immensely to education.

Although when the project was live, it was realized that there was a lack of research planning. Kheda TV was continuously adapting to local needs, but there were no detailed discussions held regarding instructional television or satellite communication. The Ministry of Education and Social Welfare, ISRO, and Ministry of Information and Broadcasting had made plans of their own.

> The emphasis seems to be on 'selling' (attractively packaged) information with the help of modern technology and equipment. It can be considered a serious drawback when the problem of instructional television is handled on the basis of advertising practices and models of dubious validity (Kale, 1973).

The thing about inspired programs is that they want to achieve everything at once, and that can cause fallouts. There were fallouts with SITE. AIR was the only broadcasting authority, and the government was barely interacting with the private sector which caused major trouble. Also, the bureaucratic procedures made it challenging to keep up with the 'developmental objectives' of the program.

The cost was going up with anticipation of Rs. 120 crores annually (out of pocket expenditure exclusive of depreciation costs and interest on capital assets) (Dhawan, 1973). The reason for this was the lack of rural electrification where it served the most, requirement of the content to be designed and translated in several languages, and, of course, the absence of private demand of TV that could potentially contribute to some revenue. Hence SITE required some strategic improvements.

Since SITE's developmental instruction goals in India were cluttered in *Krishi Darshan*, there was an immediate need to categorize content with focused programs for broadcasting. Unfortunately, this could not be achieved during the project. 'It left many vital questions from the farmers unaddressed and unanswered. *Krishi Darshan* was thus reduced to a programme for the dissemination of data and information to the *target group*' (Dhawan, 1973) (Fig. 4).

India was reaping the fruits of satellite communication in the early 1980s and was also (still) struggling to empower technology. Society was also in a constant struggle with it. India was poor and had very sensitive developmental problems but in that one year of the SITE program, Indian scientists and social scientists were able to succeed to an extent despite several difficulties (Chipman, 1982; Pal, 1979). I will let Yash Pal summarize SITE (Clarke, 1992):

> For 1500 people directly engaged in the experiment, SITE was a deep human experience. It generated new capabilities, demystified space technology, and helped to nucleate a large island of self-confidence. But of far greater significance was the generation of a new kinship between technologists and grass-root problems of the country, a common concern for the ultimate social and human goals (Vatican City, 1984).

SITE was a learning lesson toward satellite communication in India. Although it did not succeed in the way it was thought it would, in Stuart Auerbach's words "for a country that still uses bullock carts as a prime mode of transportation" it was an ambitious step (Auerbach, 1980). As Auerbach pointed out, the country lived in extremes, there was

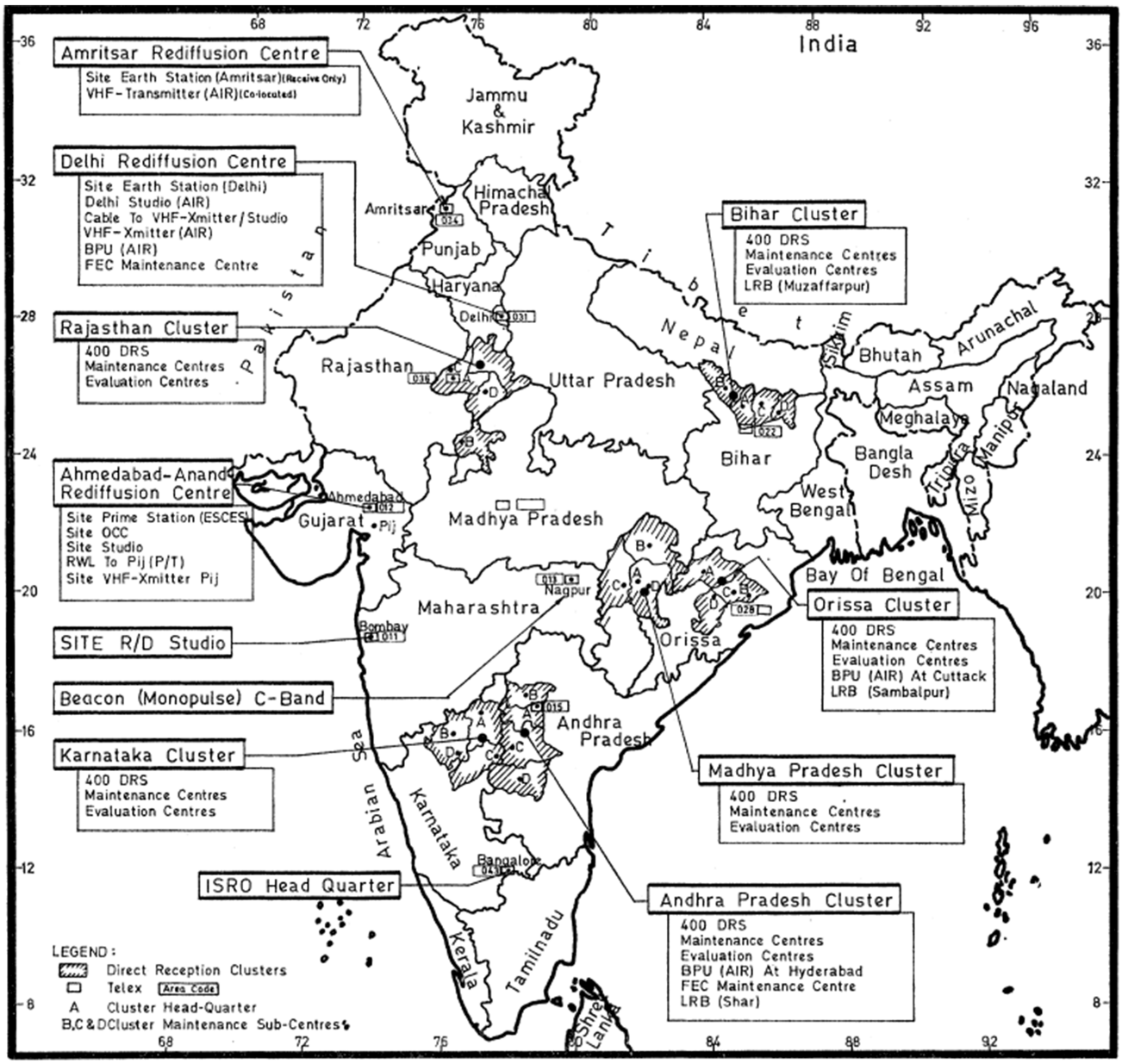

Fig. 4 Various facilities and centers that actively participated in the SITE experiment. [Credit: ISRO]

Space Program on one hand, and developmental struggles on another. The resources were unequivocally limited despite which India was able to attempt large-scale projects such as SITE.

6 Looking out

The historical landscape of India does not have a topological indemnity. Socio-political eruptions continue to change the course of the nation and its developmental objectives. Nehruvian science made it possible for India to leapfrog into big-league science by gaining support from the impeccable scientific community at the time but the romanticised leapfrogging vision had its challenges.

Post-colonial discourse is obsessed with the notion of voice. As Arnold (2013) points out [58], Nehru was the only voice of science in India. In hindsight, I am also of the opinion that Nehru spoke for the entire post–colonial consciousness. The subaltern could speak, but could the subaltern understand? I am not quite sure. It was like two different consciousness coexisted mutually exclusively.

We can see this struggle when we see the disparity between planning, execution, and reception of SITE. The

language, cultural dynamics, and most importantly the issues of the community one wanted to help were addressed at the last. It was the colonial bias that hindered the scientists to think like a free men. They thought about their fellow countrymen and women in the third person, and I believe that's where necessary checks lost their harmony. They forgot to account for science's acceptability in the traditional hegemony of Indian society. The top-down approach, which Nehru mastered because of his ideological influence over the country, did not work with the scientists.

Jacques Lacan argued that modern science encourages modern man to forget his subjective existence because he ignores the social dimension of human existence (Lacan, 1977, p. 70). However, in the case of India, and Nehru and the socialist state-sponsored science particularly, was obsessed with the social dimension of human existence and wanted science to add meaning to it. Science was provided with the ecosystem to grow in India as a socio-political development tool for the country. Scientists were dedicated to the cause, sometimes too dedicated that they forgot to see what they say without knowing what they think. The idea of a non-western science executed within the bounds of western execution of science made Nehruvian science an outsider and that led to its struggles.

Nehruvian science saw it getting enshrined in the Constitution of India[26] under democratically unusual circumstances. The development of Nehruvian 'scientific temper' became a Fundamental Duty the citizen. In addition to this was the spirit of inquiry and reform. India still awaits scientific governance. The representation of scientific thought in the parliament dropped to a greater extent. The scientists, desperate to reform, started pushing the Nehruvian scientific agenda whenever they got an opportunity. This desperation, however, proved to be counterproductive.

Nehru lived on, so did his science, but India outgrew him. India went back to the times that baffled him.

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