NOTE TO ATTENDEES: This is obviously a bit of a work in progress, both in terms of its conceptual framework and the narrative itself. I have tried something different than what I had originally proposed for the workshop but I think this is a more interesting comparative approach than the one I was pursuing earlier. Please forgive the typos as well as the length of the paper. There are obviously a number of important lacunae in the paper in terms of research questions but I would most appreciate comments/critiques in terms of the theoretical/analytical formulation that I am attempting to use. It’s a bit of a leap in the dark and terribly under-theorized and lacks a formal conclusion, hence I would benefit from your feedback. Thanks for your patience. Asif

‘Space is the Place’:
Transnational Networks and the Rocket and Space Programs in China and India

Asif Siddiqi (siddiqi@fordham.edu)
Fordham University

Introduction
This paper is framed around a comparative study of two critical episodes of knowledge circulation during the Cold War: the birth of the Chinese and Indian rocketry programs. Both these origin stories have typically been couched in terms of independent “silo”-type narratives within their respective national contexts. There are certainly common points of reference that suggest a comparative work of the two programs would be instructive. Each effort, for example, was driven and defined by domestic imperatives that were couched in the language of modernization. This link between nation, science, and modernization (and by extension “being modern”) was not particularly unique to China and India but it held special resonance for political and scientific elites who linked the possibility of the modern future with the historical valence of past civilizational greatness. But if modernity and modernization was by definition defined in relation to “the other” (i.e., the West), the actual programmatic decisions on such science and technology efforts were understood as endeavors entirely circumscribed by understandings of the nation. One manifestation of this nation-centered narrative is the vast number (as well as ambit) of studies on the histories of national (space, missile, etc.) programs such as the “Chinese rocket program” or the “Indian space program.”

Although they have been compared because they are, in many ways, comparable, the two originary stories of missile development in China and India have been understood as two entirely independent and unique moments in the history of rocketry and space exploration—narratives without imbrication that have no flow of knowledge, matériel, or people between them. I am not quibbling with this basic formulations but, in this paper, suggest that there may be alternative approaches to seeing this gestational period in the two countries that may render visible occluded networks of contacts and flows. I use as my intellectual apparatus a strategy that centers the narrative around place instead of project. By doing so, I hope to reframe the birth of modern rocket development in both China and India as a fundamentally transnational—or global—project that avoids teleology of the received narrative where there is a clear beginning and a clear

---

1 I explore the consequences of this assumption about “nation” and “space” in my National Aspirations on a Global Stage: Fifty Years of Spaceflight” in Remembering the Space Age, ed. Steven J. Dick (Washington, DC: NASA History Division, 2009), 17-35.
end. Instead, by looking at four entirely disparate and seemingly disconnected places where “things happened”—places I define as transnational sites for the exchange and translation of knowledge, matériel, and people—I reconstruct an alternate history of rocketry, some of which takes place in China, some of it in India, and some of it elsewhere, but all of it connected. These four places are Thumba (in southern Indian state of Kerala), Cambridge (in Massachusetts in the United States), Beijing, and Dnepropetrovsk (in the former Soviet Union, now in Ukraine). In my narrative, each is framed by a single imperative: Thumba’s geographical location, Cambridge’s importance as a hub of knowledge production, Beijing’s place as a center of political and elite power, and Dnepropetrovsk’s fame as city of mass production. Each site produces objects and knowledge that contribute to our understanding of the other sites, furthering my narrative. Because of my emphasis on place over project, I have loosened my attachment to chronology. In fact, as will become evident, my formulation subverts the chronology of rocket and space development in China and India in favor of non-linear connections that privilege flows of knowledge, matériel, and people in often counter-intuitive ways.

How To Be Modern in India

We begin first with India, with a brief interlude on the two principal architects of the early years of the Indian rocket and space program, Homi Bhabha and Vikram Sarabhai. Both were intimately connected with the elites of Indian polity and culture, including for example the Nehru and Tagore families, but were also instruments of Jawaharlal Nehru’s vision of creating a “scientific temper” in post-independence India. And if both their lives have been “overdetermined in the historical narrative,” in the words of Itty Abraham, it is still possible to discern some essential signposts in their influential career trajectories. Both men were born to extremely wealthy families and educated at Cambridge. Bhabha, born to an elite Parsi family based in Bombay, established himself as a bright physicist specializing in cosmic ray physics. Capitalizing on his close connections with various elite constituencies, Bhabha created a large network of research institutions in India, most notably the industry-funded Tata Institute of Fundamental Research in Bombay. Arguably his most important legacy was his nearly 18 years at the helm of the Indian Atomic Energy Commission (AEC), built from the seed of the Tata Institute and established with Bhabha’s active intervention in 1948.

Like Bhabha, Sarabhai was considered something of a prodigy; his elite and cultured sensibilities led him to a wide range of social and cultural interests and eventually to a Ph.D. at Cambridge, interrupted briefly by World War II. His dissertation, entitled “Cosmic Ray Investigations in Tropical Latitudes,” brought together his two biggest passions, India and physics. The two men had become friends at the Indian Institute of Science in Bangalore during the war and had kept in touch through independence as Sarabhai’s talents, combined with his proximity to Nehru, launched him on a spectacular career in Indian science and industry. Like

---

2 See also my initial thoughts on conceptualizing a global history of space exploration: Competing Technologies, National(ist) Narratives, and Universal Claims: Towards a Global History of Space Exploration. Technology and Culture 51 (April 2010): 425-443
Bhabha, Sarabhai used his family resources to establish a research institution, the Physical Research Laboratory (PRL), located in his family home of Ahmedabad, which specialized in Sarabhai’s field of research, cosmic ray physics. Here, the focus was less on theoretical physics than experimental work. The laboratory grew slowly but gained strength by the late 1950s with equipment imported from abroad providing young students with opportunities for new and exciting research. In the 1950s, both Bhabha and Sarabhai were instrumental in creating a network of institutions, the former in the scientific and applied research sector and the latter in Indian textiles and chemical industries.

Bhabha and Sarabhai’s technological enthusiasm did not emerge out of a vacuum but were shared by many in the West at the time who passionately believed in the power of science and technology to act as transformative instruments of the social relations. If the material manifestation of this ideology reached its apogee with Bolshevist-flavored technological utopianism in the Soviet Union, it was sharpened and given a theoretical underpinning by Western social scientists in the postwar era. Here, the most obvious touchstone for social scientists’ attempts to theorize a relationship between a monolithic idea of “development” and an equally undifferentiated notion of “underdevelopment” was Walt Rostow’s (in)famous The Stages of Economic Growth: A Non-Communist Manifesto, issued in 1960, just at the cusp of the formation of the seed of the Indian space program. Rostow’s work on the linearity of economic development, its notions of “takeoff” point in development, and its marking the West as the normative standard for development, was deeply influential for decades as modernization theory extended its grips into international philanthropic and economic institutions, many of which, such as the Ford and Rockefeller Foundations, had firm links with the South Asian elite.

Bhabha and Sarabhai’s writings of the period betray many of the predilections of the modernization theorists. Sarabhai’s meditations on development in India were almost always couched in terms of stages of growth, for example; one of his favorite phrases was for India to “leap frog” ahead to achieve developmental parity with the first world, something, he believed an Indian space program would facilitate. They also accepted without question the portability of technology. Bhabha noted late in his life that “what the developed countries have and the underdeveloped lack is modern science and an economy based on modern technology.”

Sarabhai was an enthusiast of the green revolution, its initial results in India providing him with

---

hope that new technologies of rice and wheat production would be one of the keys to a modern India.9

Although Bhabha and Sarabhai subscribed to the general tenets of the modernization theorists, their visions of development seemed not to wholly adopt or reject any singular model. At least publicly devoted to the model of non-alignment, both men were open to ideas from both the capitalist and socialist worlds. In this context, where Rostow had written an anti-communist manifesto, Bhabha and Sarabhai passionately believed—à la the Soviet model—in a massive statist presence in Indian development. Bhabha was not a socialist—in fact, as Abha Sur has shown, his favoritism towards private industry working with foreign firms was anathema to many Indian scientists such as Meghnad Saha—but he believed in a strong governmental hand in industrial and scientific policy that alienated modernization theorists.10 Bhabha explicitly wrote admiringly of the Soviet model and such ideas were clearly unpopular among American theorists invested in Indian development.11 Sarabhai, similarly, called for a kind of “totality” in development, one that not only involved all the inputs into development, for example agricultural inputs into rural areas, but also extensive state infrastructure which including bureaucratic mechanisms to manage these inputs.12 He used the same kind of thinking in the first major statement on the future of the Indian space program, a manifesto for the next ten years issued in 1970. He noted that, “there is a totality about the process of development which involves not only advanced technology and hardware but imaginative planning of supply and consumption centres, of social organization and management, to leapfrog from a state of backwardness and poverty.”13

Thumba

The fact that Bhabha and Sarabhai were open to cooperation with both the Europe/US and the Soviet bloc gave them an enormous amount of flexibility, one that manifested itself not only in the formation of Thumba, a rocket launch facility in south India, but also their choices for help in developing the initial Indian satellites such as INSAT and Aryabhata. The story here begins with the International Geophysical Year (IGY) of 1957-58 which not only gave India its first brush with space experimentation but also provided Sarabhai with his first experience with the potential advantages of the geographical specificity of India in the arena of international science. India’s tropical location, particularly the fact that its southern tip passes through the

---

9 See, for example, his two lectures on the Green Revolution, given in 1969 and 1971, reproduced in Science Policy and National Development, 123-140.
10 It’s noteworthy that in internal correspondence between NASA and the State Department in late 1961 in anticipation of a visit by Bhabha to the United States, the State Department reassured the NASA representative that “Dr. Bhabha is not considered a Communist.” See Wreatham E. Gathright to Arnold W. Frutkin, October 19, 1961, National Archives and Records Administration II (NARA II), RG 59 (General Records of the Department of State), Office of the Secretary, Special Asst. to Sec. of State for Atomic Energy Matters, 1948-1962, General Records Relating to Atomic Energy Matters, 1948-1962, Box 333, Folder 14A – Cooperative Space Program 9. India, 1961-62.
11 See Bhabha’s admiring comment of the reduced role of foreign advisors in the development of Soviet industry in “Science and the Problems of Development.”
12 Writing of the Green Revolution, Sarabhai noted in 1971 that “One of the important lessons, which has been learnt in the implementation of the measures which have contributed to the green revolution, is the recognition of the totality of the package which is required.” See Sarabhai, “The Green Revolution” in Science Policy and National Development, 138.
magnetic equator (as opposed to the geographical equator) made it a location attractive for those studying high energy cosmic rays (since low energy particles were screened off by the Earth’s magnetic field). The connection between India’s geography and the nature of its science was not, obviously, a new relationship, but it was one that took on new meaning in the postcolonial context since elite scientists such as Bhabha and Sarabhai saw such investigations as a way to offset India’s lack of scientific infrastructure as compared to the West. Here, both Bhabha and Sarabhai’s own research on cosmic rays perfectly aligned with and reinforced the connection between science and geography and gave it an international flavor during the IGY.\(^{14}\)

These seedling activities spurred Sarabhai to action. From the recollections of contemporaries, it is clear that after Sputnik, Sarabhai was committed to creating a domestic rocket and space program in India that would be independent of outside support. There is no reason to doubt Sarabhai’s stated vision of creating a program devoted to the welfare of the Indian population but his strategy for building this project depended on a number of extremely pragmatic measures. The first was to create a powerful institutional home with links to the top levers of Indian politics and industry. With Bhabha’s sponsorship, in August 1961, Sarabhai moved his Physical Research Laboratory under the umbrella of Bhabha’s Atomic Energy Commission to serve as an institutional home for the future Indian space program. Hardly mentioned in the standard histories of the Indian space program, this integration of the space program with the atomic program was an important strategic move, for the institutional and symbolic alignment between the two programs proved beneficial to both: on the one hand, the space program (Sarabhai) could invoke the authority of the atomic program; and on the other hand, the atomic program (Bhabha) could use the space program to create a patina of peaceful scientific work, useful to shield it from the frequent suspicions of Westerners who believed otherwise. Once Sarabhai moved into the managing board of the Atomic Energy Commission, in February 1962, he engineered the formation of the Indian National Committee for Space Research (INCOSPAR), which at this point, was essentially his old Physical Research Laboratory with a new name.\(^ {15}\)

The second important strategy for Sarabhai was to define INCOSPAR’s mission such that it drew upon older traditions of Indian science and at the same time provided a forum for international interest in the Indian program in the form of hardware and personnel. Early in INCOSPAR’s existence, in the early 1960s, the organization’s mission and actions fell in line with Bhabha and Sarabhai’s strategy of taking advantage of India’s geography. In particular, the organization’s scientific goals were aligned with those of Sarabhai’s own academic interests; Sarabhai zeroed in on geophysical phenomena in the Earth’s magnetic equator, particularly what geophysicists call the “equatorial electrojet,” which is a stream of electric current flowing in a narrow band of about three degrees on both flanks of the magnetic equator at altitudes of roughly

---


\(^{15}\) Gopal Raj, Reach for the Stars: The Evolution of India’s Rocket Programme (New Delhi: Viking, 2000), 6-7.
a hundred kilometers. Research on the equatorial electrojet and equatorial geophysical phenomena in general was one of the primary missions of the nascent Indian space program in the 1960s and as such, a furtherance of the connection between geography and science in the postcolonial context. Yet, this mission of INCOSPAR displayed a curious disconnect from Sarabhai’s avowed ideology of science to improve India since the social benefits of research on the equatorial electrojet were dubious at best. The focus on investigating the equatorial electrojet, however, played a significant if not critical role in the birth of the Indian space program. Sarabhai’s genius was to invoke and publicize the value of this research so as to involve the international scientific community, and more to the point, recruit Western nations who already had the capability to lift payloads up into space. Western participation in a scientific rocket program to investigate phenomena in the magnetic equator served three important functions: it gave the INCOSPAR’s activities the cloak of legitimacy as a worthwhile project; it provided India with a large amount of technological infrastructure free of charge; and it insulated criticism of the space program from a domestic audience who might otherwise wonder why India was spending money on space exploration when it had more pressing problems on the ground.

Bhabha and Sarabhai’s approach to the role of international partners was not predetermined and nor was it without fluctuations. In one of his last major statements before his untimely death in 1966, Bhabha wrote that:

The relative roles of indigenous science and technology and foreign collaboration can be highlighted through an analogy. Indigenous science and technology play the part of an engine in an aircraft, while foreign collaboration can play the part of a booster. A booster can give a plane an assisted takeoff, but the plane will be incapable of independent flight unless it is powered by engines of its own. If Indian industry is to take off and be capable of independent flight, it must be powered by science and technology based in this country.17

While this and other statements from Bhabha suggest that he was open to full-scale cooperation with the established space powers, Sarabhai was more forceful about finding the right balance between using help in the initial phases and then moving ultimately to an indigenous capability. Sarabhai’s injunction that “we do not wish to acquire black boxes from abroad but to grow a national capability” was exemplified in INCOSPAR’s gradual step-by-step program which depended heavily on international help in the early days but with the expectation of eventually gaining fully autonomous capability to build and launch (although not design) sounding rockets.18

In January 1963, INCOSPAR signed an initial agreement with NASA to launch American sounding rockets from Indian soil to investigate upper atmospheric phenomena. This arrangement perfectly dovetailed with Sarabhai’s strategy to involve Western nations in using India’s landmass as a launching pad for space experimentation. According to the deal, NASA would conduct two experiments jointly with the Indians, one to release sodium vapor at high altitudes to measure upper atmospheric winds and the other to study the equatorial electrojet. As

---

16 There were other advantages of India’s location for the conduct of space science, specifically because the Van Allen radiation belts are so high that ionospheric research is not exposed to the kind of interference common at higher latitudes.
17 Bhabha, “Science and the Problems of Development.”
18 For the quote, see Raj, Reach for the Stars, 24.
part of the program, NASA would donate four Nike-Cajun rockets and nine Nike-Apache rockets. The Indians would furnish the sodium vapor release experiments while the Americans would supply the electrojet study payload. NASA would also provide a whole host of equipment, all of which (besides the rockets) was on loan. The agreement emphasized that “[n]o exchange of funds is provided for and all scientific results of the experiments will be made freely available to the world scientific community.”

By the time that NASA agreed to this arrangement, Sarabhai and Bhabha, with the help of a colleague of Sarabhai’s from the Physical Research Laboratory, E. V. Chitnis, found an appropriate place for these launches at Thumba, a village close to the Kerala capital of Trivandrum in south India close to the magnetic equator. Using the vacated premises of a church, INCOISPAR employees set up the skeletal infrastructure to support these launches. Sarabhai also obtained equipment from both the French and the Soviets, including a helicopter and a computer procured from the latter during a trip to Moscow in 1962. The culmination of all this activity was the launch, from Thumba, on November 21, 1963 of a Nike-Apache rocket. In concert with two Americans and two French technicians, the Indians—almost all of them protégés of Bhabha and Sarabhai from their research infrastructure—successfully launched a French sodium payload up to altitude, which spread a bright orange cloud trail that was visible to many from the ground. This even has since assumed an iconic status in the literature—all official histories date it as the birth of the Indian space program.

American, Soviet, and French (and later British) involvement launching rockets from Indian soil began the process of legitimizing Indian involvement in rocketry and space but it was the role of the United Nations that firmly reinforced this legitimacy. In 1962, the UN-sponsored Committee on Space Research (COSPAR), a forum for space scientists to discuss their research at an international level, noted that “the magnetic equator is highly significant for the investigation of the earth’s magnetic field and the ionosphere,” and called for establishing sounding rocket facilities in regions close to the magnetic equator. Sarabhai quickly saw this as a perfect opportunity to bring his plans into increased visibility globally. UN sponsorship would not only make his Thumba launch site a nexus for global activity involving the most advanced rocket technology but it would also insulate the space effort from domestic critiques and provide the umbrella nuclear program—which oversaw the space program—with the sheen of peaceful exploration. Soon after COSPAR’s call, Sarabhai offered Thumba as a potential location for a UN launching sounding rockets from the equator. Later, the UN’s Committee on the Peaceful Uses of Outer Space issued a resolution in December 1965 explicitly stating that:

> the creation and use of sounding rocket launching facilities (especially in the equatorial region and the southern hemisphere) under United Nations sponsorship would contribute to the achievement of the objectives of [the] General Assembly . . . by greatly furthering international collaboration in space research and the advancement of human knowledge.

---

This resolution formally made the now-renamed Thumba Equatorial Rocket Launch Station (TERLS) an “international range for scientific research open to all UN member states.” A little over two years later, having already clocked in 52 international rocket launches, Indian Prime Minister Indira Gandhi visited Thumba to dedicate the launch station as an international facility, symbolically handing the launch site over to the United Nations. Foreign donors had contributed about $3 million (in 1968 values) to the upkeep of the launch site which was completely operated and maintained by Indian engineers and technicians under H. G. S. Murthy, a senior engineer at INCOSPAR who had been on the initial training trips to NASA in the early 1960s. By this time, the Indians had entered into a vast number of agreements with international partners—principally the United States, France, the Soviet Union, Japan, and Great Britain—to enhance the capabilities of the domestic space program. These agreements included obtaining sounding rockets and instrumented payloads for scientific experiments, procuring equipment to support Thumba operations, continued training for Indian engineers at foreign rocket and space facilities, and opening a satellite ground communications station. Almost all of these activities were furnished free of charge by the cooperating nation as a gesture of good faith to maintain the UN-sponsored Thumba Equatorial Rocket Launch Station.

As a result of these agreements, Thumba became a fundamentally unique site in Cold War science. For the global scientific community, its most important symbolic value was as a site for the shared scientific interests of Cold War adversaries. For the hosts, Thumba possessed an entirely different import—for them, it was the training ground for a generation of Indians, a site where technology could exchange hands without concern, providing Indians with an extraordinary window into contemporary sounding rocket technology.

Indians working at Thumba were a varied lot, but almost all of them—especially mid-level and senior engineers—shared one rite of passage: they had done their graduate work in American (and to a lesser degree, British) institutions of higher education. More strikingly, the number and prominence of alumni from MIT was noteworthy and included: Eknath V. Chitnis, who played perhaps the most important role in the selecting the actual geographical site for Thumba and worked with Bruno Rossi’s Cosmic Ray Group at MIT from 1958 to 1961; Yash Pal, who received his Ph.D. in physics in 1958 from MIT, and who later became director of the Space Applications Center at the Indian Space Research Organization; and Brahm Prakash who completed his Sc.D. in 1949 at MIT in metallurgy, and much later headed the rocket vehicle development center of ISRO. Of course, the most important connection with MIT was through Vikram Sarabhai who had a formal appointment with MIT throughout the 1960s as a Visiting Professor in the Physics Department. Sarabhai frequently travelled to Cambridge, not only to

24 Sarabhai’s mantra that India was not interested “in acquiring black boxes” manifested itself most starkly in INCOSPAR’s deal with the French space agency, Centre National d’Etudes Spatiales (CNES), signed on May 15, 1964, to manufacture under license Sud Aviation’s two-stage Centaure IIA sounding rockets locally. See La débuts de la recherché spatiale française: au temps de fusées-sondes (Paris: Institut français d’histoire de l’espace, 2007), 78-79.
cooperate in research projects at Bruno’s lab but also to maintain networks that extended far beyond Cambridge, of elite experimental physicists and aeronautical engineers.

**Cambridge, Massachusetts**

Ross Bassett’s work has been instrumental in highlighting the way in which MIT was a fertile educational site in the colonial period for scores of diaspora Indians. The nearly one hundred Indians who were granted doctoral degrees, almost all of whom returned home, brought back with them a diverse set of experiences that informed their activities in India. Bassett notes that “[i]n the first forty years of independence, MIT graduates occupied an astounding number of the highest-level positions in the Indian technical community—more than graduates of any other single school in the United States or the United Kingdom, and quite possibly more than the graduates of any single school in India.”

This tradition of Indian elites going to elite universities in the U.S. continued past 1947, complemented now by efforts to replicate the MIT model in India through the founding of several new institutions, including several campuses of the Indian Institute of Technology (IIT), particularly the one at Kanpur, and the Birla Institute of Technology and Science. The IIT system as well as Birla served as a major training node for dozens of Indian engineers who later went on to work for ISRO in the 1970s and 1980s.

There were other resonances of the MIT connection with India. In the late 1960s, Sarabhai had talked frequently of building a domestic direct broadcasting satellite known as INSAT. Daniel Lerner, a social scientist at MIT who specialized in the role of communications in development, and served as Sarabhai’s advisor in the late 1960s wrote glowingly of Sarabhai’s proposal to bring direct TV broadcasting to the India. Lerner noted that the project was a “brilliant example of leapfrogging,” adding that “[g]iven the problems raised by India’s acceleration of history and its instant mobilization of the periphery, this type of leapfrogging over the long western experience is what India needs most.” Around the same time, Walt Rostow’s older brother Eugene Rostow, the influential legal scholar, authored a key report in 1969 on the educational role of TV in developing nations that was a major factor in the conception of Sarabhai’s TV broadcast experiment, which involved the use of an American communications satellite to broadcast educational programs to thousands of villages in India.

As the idea began to coalesce around 1969-70, Sarabhai’s expectations seemed to be colored by his general technological enthusiasm: he envisioned an array of eager users in India such as All India Radio, the Railways, Civil Aviation, Ministries of Health, Family Planning, Education, Agriculture, Posts and Telegraphs—in fact, pretty much every sector of Indian society involved in development. This satellite was to be all things to all people, a virtual technological panacea for the poor that that would be a boon to both civil and civilian society in India, a new way for the use of space, based on Gandhian principles that avoided the precedent established by the superpowers.

---

Building on some initial exploratory studies done both with NASA and U.S. industry, Sarabhai reached out to MIT—in specific, its associated Lincoln Laboratories—to assist in conceptualizing INSAT. Lincoln Lab had been established in 1951 on the outskirts of Boston to institutionally support research and development on the nation’s air defense system. By the late 1960s, it had become one of the central nodes in MIT’s connections with the Department of Defense, a place where the bulk of MIT’s classified research into weapons occurred. Sarabhai’s interest was piqued by the fact that Lincoln Lab had developed devices and techniques for military satellite communications for the U.S. Air Force.

Because Lincoln Lab’s funding came directly from the Department of Defense—although it was formally associated with MIT—Sarabhai reached out to the Pentagon in the fall of 1969. In October, Sarabhai wrote to U.S. Secretary of the Air Force Robert Seamans to inquire about the possibility of Lincoln Lab initiating a joint study with Indian scientists and engineers on a communications satellite. Seamans was quick to respond to Sarabhai, sending off a short note that he (Seamans) had spoken to MIT Provost Jerome Weisner about Sarabhai’s proposal but that, presumably due to security restrictions the proposal needed to be reviewed “with us here in the Air Force in order to determine its suitability.” He added that he had “every hope that it will be possible to help you in this fashion.”

Once Seamans enabled the arrangement, there remained two major hurdles: to determine the scope of the project; and to determine a source of funding. With respect to the latter, Sarabhai clearly had in mind a project to design a satellite whose first production model would be made in the United States, with follow-on models made in India. For funding, he believed that either USAID or the Ford Foundation would come through. Jerome Weisner, an old friend of Sarabhai’s during his stints as a visiting professor there, was enthusiastic and pushed Lincoln Lab to fund the initial phase of research. Lincoln Lab director Milton Clauser, less enthusiastic than Weisner, agreed to take on phase 1 of the project, i.e., the early conceptualization of the satellite, but declined to provide the estimated $80,000 needed. Here, Weisner came to Sarabhai’s help and solicited the Ford Foundation—that institutional nexus for American efforts to develop the world à la Rostow—to provide funds, which they did, an amount of nearly $66,000 for the first part of the study to be carried out at Lincoln Lab. The study was led by F. William Sarles, Jr., a well-known communications satellite expert at MIT who had worked on a military communications satellite project in the 1960s; the Indian team (of six men) was led by Pramod Kale, one of Sarabhai’s key deputies. The MIT-based INSAT study was finished in March 1971, and produced a workable design for a TV broadcasting satellite.

---


33 These were the eight satellites launched between 1965 and 1976 in the Lincoln Experimental Satellite (LES) series.

34 Seamans to Sarabhai (November 4, 1969), MIT/Lincoln Lab Archives.

35 Sarabhai to Weisner (January 6, 1970), MIT/Lincoln Lab Archives.

36 Weisner to Clauser (February 2, 1970), MIT/Lincoln Lab Archives.

37 Clauser to Weisner (March 4, 1970), MIT/Lincoln Lab Archives. The $80,000 estimate was arrived at by D. C. MacLellan. See MacLellan to Rosen and Wozenrcraft (February 17, 1970), MIT/Lincoln Lab Archives.

38 Nims to Johnson (July 30, 1970), MIT/Lincoln Lab Archives.

INSAT, as proposed by the MIT study was supposed to be launched in 1975 but the project was almost immediately derailed by three factors: Sarabhai’s untimely death in December 1971, the Bangladesh war of independence that drove a wedge between U.S.-India relations, and bureaucratic inertia and infighting in the Indian government over the need for such a satellite. The result was that the government did not formally approve INSAT until November 1975, nearly five years after the MIT study. The first INSAT was finally launched in 1982, by which time the original broadcasting satellite had evolved into a multi-purpose applications satellite platform for TV broadcasting, telephone and data communications, and remote sensing.

Nevertheless, as Y. S. Rajan, one of the original MIT study members recently noted, the MIT study was “the most important satellite study done under Sarabhai” in terms of its “long-term significance.” Beyond establishing a baseline satellite design configuration that would become the standard for the ISRO in the 1980s, the experience at MIT provided hands-on applied science and engineering experience to several Indians, including Kale and Rajan, who later headed important projects back in India.

MIT’s role as both a training node for scientific and engineering elites, and its links to industry, the defense department, and counter-culture movements has been the subject of much scholarship. Yet, MIT was also an important training node in a global network of scientific elites, one that included other Western institutions such as Caltech and Stanford in the U.S. and Cambridge and Oxford in the UK. One of the largest foreign student populations at MIT in the first half of the 20th century—far overshadowing the Indian contingent—was from China. Already by 1915, there were 46 Chinese students at MIT, the largest foreign student population, and by the time of the revolution in 1949, over 300 students had received their higher education from China, almost all of whom returned back home. They constituted a small but important segment of roughly 22,000 Chinese who studied in the U.S. over a period of 100 years. The number in the U.S. in 1949 amounted to roughly 5,000.

McCarthyism and general anti-Communist hysteria created adverse conditions for Chinese studying in the United States, and contributed to a brief period after 1949 when large numbers of Chinese returned home. Yet, soon by 1951, as Zuyoue Wang has shown, “a gradual change in U.S. policy began to make it increasingly difficult for Chinese students and scientists


41 Interview, Y. S. Rajan, Bangalore, August 5, 2011.


to return to China.”\textsuperscript{45} The ones who returned were seeded in key positions in the Chinese scientific and military-industrial communities. Wang notes that between 1949 and 1956, of those who came back to China, 129 went to work in the elite Chinese Academy of Sciences. He adds, “[b]oth individually and as a group, it is difficult to overestimate the importance of those returned students and scientists to the Chinese nuclear weapons and space programs.”\textsuperscript{46} Of the higher echelon of the Chinese Academy of Sciences, more than a quarter earned their graduate degrees in the United States, and of these MIT was by far the largest in terms of degrees granted (21 Ph.D.’s).\textsuperscript{47} Three of the most important scientific and engineering heads of the nascent Chinese missile and space programs were intimately connected with MIT. They included Liang Shoup (梁守槃) (1916-2009) who obtained his graduate degree at MIT in 1940, and was the leading rocket propulsion expert in the early missile program. There was also Shou Tu Ngok (1917-2012) who graduated from MIT in 1943, worked for a while at a Curtiss Aircraft factory in Buffalo, New York, and later, upon his return to China, was in charge of perhaps the most high priority missile program in the late 1950s, the effort to reverse engineer and produce a domestic version of a Soviet ballistic missile. Undoubtedly, the most famous alumnus of MIT was, of course Qian Xuesen, considered by many to be the “father” of the Chinese missile and space program.

Did the return of Chinese scientists and engineers contribute to the “Americanization” of Chinese science, at least in the short term? Wang qualifies it as a “partial Americanization,” a kind of co-production of knowledge systems that accumulated practices, institutional modes, and ideologies rooted in the United States, China, Europe, Japan, and the Soviet Union, facilitating a transnational process of knowledge circulation. Much like the imported but locally shaped modernization theories in play in the Indian context, returned diaspora of Chinese scientists appear to have preferred some token if not substantive institutional features of the American educational model. Wang describes Qian Xuesen’s advocacy of the “American model of innovative scientific education”—presumably the emphasis on experimentation in pedagogy—in place of existing Chinese arrangements. What is certain is that the U.S.-returned diaspora had enormous clout once they returned. Wang notes that:

the students and scientists were welcomed back in China with open arms, and many of the returnees took key positions in the Chinese research, development, and educational systems, especially in the defense sector. The cutting edge science and technology they brought back gave the Chinese leaders growing confidence that China could indeed launch its modernization drive. It may have also encouraged the Chinese leadership to pursue increasing independence from the Soviet Union.”\textsuperscript{48}

Beijing

Most if not all accounts of the birth of Chinese space and missile programs follow a received narrative that puts a “father figure” at the center, in this case Qian Xuesen (钱学森) (1911-2009), the charismatic U.S.-educated scientist who pushed through initiatives that

\textsuperscript{46} Wang, “Transnational Science during the Cold War.”
\textsuperscript{48} Wang, “Transnational Science during the Cold War.”
strengthened efforts to develop missiles and satellites. Qian’s well-known story is worth repeating to highlight both points of similarity and exception other Chinese elites of his generation. Like most foreign educated Chinese scientists of his cohort, Qian completed his graduate education in the United States, moving at first to the MIT, where he earned a master’s degree in 1936, and then eventually to the California Institute of Technology. Having trained under mathematician Theodore von Kármán at Caltech, Qian eventually co-founded the Jet Propulsion Laboratory in Pasadena, California as a central node for advanced rocket propulsion research in the U.S. His interests were wide, his accomplishments notable, and his ambitions— at least in his chosen discipline of aeronautics— boundless. As his research gravitated towards long-range rocketry and space research, events outside of his control impinged on his career path. Accused of being a communist at the height of McCarthyism in 1950, the FBI revoked his security clearance. When he decided to go back to China, he was forcibly put under house arrest where he languished for a good five years. Disgruntled with the way the U.S. government had handled his case, he permanently returned to China in September 1955. 49

As soon as he returned to China, Qian proposed a plan to initiate the development of long-range missiles in China. In February 1956, he submitted a proposal to the Central Committee of the Communist Party to develop the national aerospace industry. His report was partly instrumental in the formulation of an 11-year plan to develop and attain independence in various technologies such as rocket and jet technology. 50 The plan drew the attention of Party members at the top level, in particular Zhou Enlai, at the time the Chairman of the National Committee of the Chinese People’s Political Consultative Conference, the most powerful advisory body to the Communist Party hierarchy. Through Zhou’s intervention, the Chinese government formed, on March 14, 1956, the first institutional body to organize ballistic missile development, the Aviation Industry Committee. This committee was headed by Marshal Nie Rongzen (聂荣臻), a key figure in both the atomic energy and missile programs of China. 51 Mao Zedong was involved in early discussions about the ideal strategy to cultivate a missile program, but emphasized, as he did with the atomic energy program, that maximum use be made of Soviet assistance for the missile program. 52

Several institutions were set up by the Chinese Party and government in the 1956-58 timeframe, largely on the initiative of Qian and Nie, that consolidated efforts to create the very basic infrastructure to support a ballistic missile program. In May 1956, Nie submitted to the Central Committee of the Communist Party “An Initial Proposal to Establish Missile Technology Research in China.” Zhou Enlai personally approved the idea and tasked Nie and Qian with establishing a research institution— ultimately known as the Fifth Academy of the Ministry of

49 Biographical details are from Iris Chang, Thread of the Silkworm (New York: Basic Books, 1995).
51 The Committee was merged into the Committee of Science and Technology for National Defense (CSTND or COSTIND) in October 1958. Since that time, COSTIND has remained China’s principal governmental body in charge of the managing China’s missile and space programs.
Defense—to oversee its implementation. Fully operational by October 1956, the Academy’s offices were set up in a former military hospital west of Beijing under the tutelage of military veteran Zhong Fuxiang (director) and Qian himself (deputy director). At least 150 young university graduates were recruited for work at the Academy, but the key engineering leaders, besides Qian were the two MIT-trained experts Liang Shoupian and Shou Tu Ngok, and a third scientist, Huang Weilu (黄纬禄) (1916-2011), a graduate (1947) of Imperial College London.

Creating a ballistic missile program from the ground up was a tall order for Chinese industry. Some like Nie would talk in language that eerily prefigured the rhetoric of Indian system builders such as Vikram Sarabhai ten years later. In a letter Nie sent to the Central Committee of the Communist Party in October 1956, he wrote that the China’s policy in building a missile program should be “mainly self-reliant, but should acquire some foreign assistance to employ technology developed in the Western countries.” Unlike India, however, the entire project to develop indigenous rockets was wholly driven in China by military imperatives, and thus its place in the matrix of Chinese science and technology was defined not only by secrecy but also by sensitivities to Chinese foreign policy, the most important external relationship being with fellow socialist ally, the Soviet Union.

The Soviet contribution to the development of the Chinese missile program has been the subject of much cursory journalistic writing but, lacking any in-depth scholarly investigation, it has been difficult to situate and contextualize in the overall scope of Soviet-Chinese exchanges over science and technology in the 1950s. From the very inception of Communist rule in China in 1949, the two sides began discussions about mutually beneficial cooperation. Besides common ideological foundations, both sides shared common security concerns, reinforcing ties in the light of a perception of general isolation in the international arena. Beginning in 1950, the two sides signed a series of economic agreements designed specifically to help China industrialize on a massive scale through the transfer of designs of industrial equipment, shipment of manufacturing technologies, assignment of Soviet experts to Chinese industry, and training of Chinese experts, both domestically and in the Soviet Union. Sectors targeted included the industries of steel, petroleum, machine tools, heavy machinery, power plants, automobiles, tractors, locomotives, films, heavy artillery, tanks, jets, and airplanes. As Zhang et al. note, “China had not manufactured most of these products; if it had, Chinese products were substandard. But now China sought to acquire the design of accessories and equipment that Chinese factories could manufacture.”

Undoubtedly, Soviet technical assistance and technology transfer was a boon for the development of Chinese science, industry, and education. One central institutional actor in this exchange was the Chinese Academy of Sciences who, although populated by a significant coterie of Western-educated elites, was compelled to adopt practices considered normative in Soviet science and industry. In October 1952, for example, as Soviet assistance began to take off, the Academy leadership approved “The Decision of the [Academy] on Strengthening the Learning

54 For an account that favors chronology over analysis, see Brian Harvey, China’s Space Program: From Conception to Manned Spaceflight (Chichester, UK: Springer-Praxis, 2004), 24-25.
and Introducing Soviet Advanced Science.” By 1953, apparently, over 90% of staff of the Academy could speak Russian while nearly 75% could read Russian. The orientation towards the Soviets happened on a wide scale in several economic and industrial branches. Institutionally, for example the Chinese adopted many prevailing Soviet forms of personnel and organizational norms in the Chinese Academy of Sciences (the disengagement of the Academy from pedagogy, for example), industrial enterprises (having “special committees” for extraordinary projects), and R&D organizations (having a “first deputy chief” for managerial control of projects).

Military cooperation was a fundamental aspect of Chinese-Soviet relations almost from the very moment that the Treaty of Friendship was signed by Stalin and Mao in February 1950. Initial Soviet assistance included the assignment of nearly 4,000 Soviet “advisors” from the Navy and Army in various Chinese installations, followed by the delivery of MiG-15 aircraft in March 1950. Such arms deliveries became more common through the decade but a substantive change came in the late 1950s with an evolution to the question of weapons of strategic value (such as missiles and atomic bombs) but also transitioning the discussion to not simply purchase but the capability to indigenously produce such items. With these ideas in mind, on July 17, 1956, Vice Premier Li Fuchun (李富春) sent an initial exploratory letter to Nikolai Bulganin, the Chairman of the Soviet Council of Ministers, for assistance with the missile program. As a result, the Soviets handed over two R-1 missiles to the Fifth Academy on December 29 at a ceremony in Beijing.

The R-1, being practically obsolete in every way, was not exactly what the Chinese were seeking. For all intents and purposes, the missile was a Soviet version of the (in)famous German A4 (or V-2) missile that the Peenemünde team had developed in Nazi Germany during the war. The Soviets had briefly deployed the missile, with a range of about 270 kilometers, in the early 1950s but almost all had been decommissioned. Disappointed with the Soviet delivery, Qian nevertheless approved a plan to reproduce the missile using Chinese industrial resources. Echoing the exact same strategy that the Soviets used after World War II, Qian saw industrial manufacture of an already proven product using local materials as a step in creating infrastructure absolutely necessary for more ambitious projects. As such, in March 18, 1957, he approved a plan to produce a Chinese version of the R-1.

Much more was, however, needed, and came at the intervention of Zhou Enlai himself who wrote to Bulganin on August 6, 1957 with an entreaty to help with national defense, particularly with areas in aviation, computing, missile development, and atomic energy. Chinese administrators and Party leaders, particularly Nie and Zhou Enlai, appear to have had an integrated plan of action in mind that emphasized links among these key sectors. In other words, each of these technologies—computing, rocketry, aviation, and nuclear power—were seen as intimately linked to each other as part of a long-range plan of developing the strategic military capability of China. In this matrix, rocketry played a central role based on the belief of its synergistic connection to a variety of sectors would energize the building of infrastructure to support a wide range of military developments. Within the seedling missile industry, particularly

---

59 Li was also the chairman of the State Planning Commission, the governmental body nominally in charge of economic planning at the state level.
the leadership of the Fifth Academy, Qian and Zhong Fuxiang, strongly believed that Soviet help would be indispensible.\(^{61}\)

In July 1957, Marshal Nie Rongzhen signed a new pact with the Soviet government ("New Defense Technical Accord, 1957-1958"), officially ratified on October 15, 1957 wherein the Soviets offered to provide missile and aviation equipment, blueprints, and experts on loan to China. The highpoint of this agreement was the delivery, on December 24, 1957, of two Soviet R-2 missiles (and associated ground facilities, blueprints, and testing equipment) to the Fifth Academy in Beijing. The R-2, although possessed of better performance than its predecessor (a range of 600 kilometers), was already consigned to history by Soviet designers, for they had moved far ahead by that point to develop truly strategic and intercontinental missiles. Igor’ Larionov, one of the Russians assigned to Beijing recalls that the “Chinese were unhappy with the R-2” but adds that the Chinese worked “with special diligence, showing zeal and perseverance.”\(^{62}\) At the time, the Fifth Academy, with Soviet help, organized two subordinate teams to manage the missile program: the “First Institute,” located in the southwestern Beijing suburb of Yungang responsible for overall missile design and propulsion, and the other, the “Second Institute,” located off Yongding Road in eastern Beijing responsible for missile control systems.\(^{63}\)

An initial team of Soviet engineers spent a three-month stint in Beijing in early 1958 to set up the basic infrastructure for Chinese production of the R-2. That the Soviets took this program very seriously is underscored by the selection of the people assigned to head the next team of Soviet engineers who arrived in August 1958 to organize production runs of the R-2. Heading the Soviet team were Petr Ivanovich Meleshin (1919-1995), a direct deputy to the highly influential “Chief Designer” of the Soviet missile program, Sergei Korolev; Meleshin had also served as the “lead designer” of the R-2 back in the late 1940s and early 1950s and thus knew the rocket better than anyone. Accompanying Meleshin was Nikolai Sergeevich Shniakin (1901-1966), one of the most highly respected and experienced experts in the manufacture of rocket engines in the Soviet defense industry.\(^{64}\) Both Meleshin and Shniakin worked closely with Qian who orchestrated the initial production of parts of a Chinese version of the R-2 at a factory in Beijing. More help came in January 1959 when six more R-2 rockets arrived in Beijing.\(^{65}\) Further deliveries of other missiles were planned for 1959 and 1960.\(^{66}\)

The cooperative relationship between the two, especially at the highest levels was always steeped in ambivalence and anxiety, exacerbated by the deep changes both within the Soviet

---

\(^{61}\) The two had written a formal request to the Central Committee on August 30, 1956 proposing “foreign assistance” to develop China’s missile program.


\(^{66}\) “Письмо председателя государственного комитета совета министров ссср по авиационной технике П. В. Дементьева в совет министров ссср о поставках оборудования в КНР (11 Декабря 1959).» Китайская народная республика в 1950-е годы: сборник документов, в двух томах, Том 2, ред. В. С. Мясников (Москва: Памятники исторической мысли, 2010), 464-465.
Union, such as de-Stalinization and the goals of international socialism. That Soviet engineers at the ground level such as Meleshin and Shniakov had little or no indication that the relationship would so abruptly be terminated, suggests that there were obvious gaps between perceptions of the Sino-Soviet relationship at the highest levels and perceptions among rank and file engineers. Yanping Chen writes specifically that “the missile developers did not know that political tensions between the Chinese and Soviet Communist parties had reached a critical juncture.”

Ultimately, of course, these fissures opened up into a chasm, and by 1960, the Sino-Soviet split threw a deep pall over any and all plans for cooperation between the two countries. As the Sino-Soviet disagreements over a variety of issues reached a critical (and very public) juncture, Soviet Party members interceded in all cooperative agreements, but especially the ones of a defense character. In early 1960, Soviet missile designers began to leave Beijing, with the last one leaving on August 12. All further deliveries, including ones that were promised in prior agreements, were postponed and finally canceled. Two days after the departure of the last Soviet specialist, Nie Rongzhen held a meeting at the Fifth Academy where he basically stated the obvious, that the Chinese would have to go it alone: “We have to do things by ourselves. We cannot depend on others. We place our hopes in you, our missile experts.”

The most immediate goal of the post-Soviet period was to produce a fully Chinese version of the Soviet R-2, a rocket which was given the unimaginative designation “1059.” The key individual who kept the project going was MIT-trained Liang Shoupan, the “chief engineer” of the 1059 project. Under Liang’s direction and in the presence of both Qian and Marshal Nie, the Chinese launched their first long-range ballistic missile, the 1059, from a remote location in the Gobi Desert, on November 5, 1960. The rocket successfully flew 550 kilometers and reached its target. Two more successful tests on December 6 and 16 confirmed that the Chinese confidence in their institutions, practices, and the training of ground personnel at the Fifth Academy. These launches are typically remembered in official Chinese histories as founding moments in the Chinese missile and space program. Less remembered is a launch of one of the Soviet-made rockets (albeit with Chinese supplied rocket propellants), which was fired a month earlier, on September 10, a training exercise to verify all the systems for an all-Chinese rocket. This rocket was manufactured not in Beijing, but much farther away in a large industrial city in Soviet Ukraine, Dnepropetrovsk. It is here that our narrative, from Thumba, to Cambridge, Massachusetts, to Beijing intersects with another Indian story.

**Dnepropetrovsk**

Of all the “closed cities” of the Soviet Union—ones where a high degree of defense factories were concentrated and population flows tightly controlled—Dnepropetrovsk was the most idiosyncratic. Located on the banks of the Dnepr river and the fourth largest city in Ukraine, Dnepropetrovsk was home to some of the most highly classified Soviet organizations, deeply involved in the missile, nuclear, and space industries. Yet, as Sergei Zhuk has shown in his wonderful biography of the city, *Rock and Roll in the Rocket City*, it was also a place of contradictions: even as the CIA listed the city as one of its most important intelligence targets, local youth readily embraced Western popular culture and certain forms of religiosity, including

---

69 Chen identifies the “chief engineer” of 1059 as “Liang Souye” while Harvey says it was “Tu Shoue.” See Chen, “China’s Space Activities, Policy and Organization, 1956-1986,” p. 235; Harvey, *China’s Space Program*, 29.
Christianity but also Hinduism (inspired by the Beatles), as a mode of both resistance to Soviet structures of control.\textsuperscript{70}

In this odd mix of influences was seeded the largest missile production factory in the world, the so-called Yuzhnyy (or Southern) Machine Building Factory, usually shortened to Yuzhmash. When Nikita Khrushchev spoke of Soviet missiles “coming out of factories like sausages,” he was referring to Yuzhmash. Co-located with the factory was a lesser known organization, the Yuzhnaya Design Bureau, the developer of the most capable intercontinental ballistic missiles in the Soviet Cold War arsenal. The history of Yuzhmash (the factory) and Yuzhnaya (the design bureau) date back to the 1950s. It is a history that is like many other Soviet military-industrial enterprises with one exception: the history intersects at key points with networks in both China and India.

After World War II, the first products of Soviet missile development were the R-1 (a Soviet copy of the Nazi V-2) and the R-2 (a domestic and improved version of the German rocket). These were “designed” by the famous Scientific-Research Institute No. 88 under the tutelage of Sergei Korolev, the “founder” of the Soviet space program. In demand of a large production facility to manufacture these rockets on a mass scale, Soviet industrial leaders, including Nikolai Bulganin, who would later orchestrate Soviet-Chinese military cooperation, identified a large automobile factory in Ukraine which had been set up during wartime. In May 1951, the factory was re-consigned to the Ministry of Armaments, then responsible for the ballistic missile program, and all future production of R-1 and R-2 missiles transferred there.\textsuperscript{71} Its code name was simply “Factory No. 586.” One of the first engineers on the scene at the factory, in the fall of 1951, was Nikolai Shniakin, the engine specialist who would, in seven years escort missiles manufactured on the factory floor at Dnepropetrovsk to Beijing.

Although the factory was originally set up as a production facility, some of the senior personnel at the factory decided that they wanted to design their own missiles instead of mass producing ones for others. As a way of creating a redundancy in the design of long-range missiles, Bulganin sanctioned the creation of a new design group at the factory in April 1954 and appointed a talented engineer (and good communist) named Mikhail Iangel’ to head it.\textsuperscript{72} This proved to be a fortuitous selection, for under Iangel’s leadership, this small design group became, within a decade, the most important developer of ICBMs. By the mid-1960s, Iangel’s stature had him hobnobbing with the likes of Nikita Khrushchev and Leonid Brezhnev, and brought an enormous building boom into Dnepropetrovsk. The city became identified with missiles, and engineers, technicians, and managers flocked to the city to work.

Iangel’s ambitions eventually led him to the next sector beyond missiles, space. In the early 1960s, his Yuzhnaya Design Bureau began an aggressive program of developing small and medium-sized satellites for the military and scientific communities while also fielding a reliable family of satellite launch vehicles. These were not the achievements that brought public recognition to the Soviet space program—Iangel’s rockets did not launch cosmonauts or grace


\textsuperscript{71} Orders for R-1 and R-2 production were signed on June 1 and November 30, 1951, respectively. There are a number of official histories of Yuzhmash/Yuzhnaya. See V. Palko, V. Platonov, and V. Pantchenko, «Днепровский ракетно-космический центр: краткий очерк становления и развития» (Днепропетровск: ПО ЮМЗ/КБ Ю, 1994); С. Н. Конюхов, ред., «Призванны временем: ракеты и космические аппараты конструкторского бюро «Южное»» (Днепропетровск: Арт-Пресс, 2004).

\textsuperscript{72} С. Н. Конюхов, ред., «Ракеты и космические аппараты конструкторского бюро «Южное»» (Днепропетровск: ГКБ «Южное» им. М. К. Янгеля, 2000), 8-10.
the cover of magazines—but he developed Yuzhnoye’s reputation as a highly dependable organization with an enviable professional work culture. For this reason, when Soviet Party functionaries signed agreements to implement joint space science programs with “friendly socialist countries,” Yuzhnoye was the ideal choice. So when Vikram Sarabhai inquired among his Soviet colleagues in 1971 about the possibility of drawing from Soviet expertise to build an Indian satellite, Soviet planners immediately suggested Yuzhnoye as the ideal partner.

Sarabhai, during his stint as head of INCOSEPAR and later as head of the newly formed Indian Space Research Organisation (ISRO) evinced an openness to scientific and technical collaboration with any and all nations capable and interested in doing so. As early as 1961, he had visited Moscow in the hopes of obtaining equipment for satellite tracking. A few token agreements in the 1960s brought some Soviet equipment, such as computers, back to Thumba. But when Sarabhai initiated his studies of INSAT, including the one at MIT, he also understood that before INSAT was launched, Indians would have to master a much simpler satellite, and for that they would need help too. Foregoing NASA, in 1971, Sarabhai reached out through contacts in the USSR Academy of Sciences on the possibility of Soviet assistance to build a rudimentary Indian satellite.

Fortuitously, the political climate at the time also favored a closeness between India and the Soviet Union. While political (and as a result, technical) cooperation with the United States had been very close through much of the 1960s, the 1971 Bangladesh war of independence, where the United States threw its full support behind (West) Pakistan in their brutal attack on East Pakistan, introduced a certain coolness in relations between the two countries. Sarabhai’s “feelers” to Soviet science thus emerged as a rational and opportunistic response to de-prioritizing cooperation with American institutions, and built upon a major friendship agreement signed between the Soviet Union and India in August 1971. This set the stage for a series of intensive discussions through late 1971. Sarabhai’s untimely death in December appears not to have impeded work on an agreement between the two sides for program of cooperation in space activities. Signed into law on May 10, 1972, the arrangement invited the Soviet Academy of Sciences to provide advisory and technical assistance to India in producing a satellite as well as providing a launching rocket free of charge. Sarabhai’s successor, Satish Dhawan, strongly supported the project, which was presented to the Indians as being implemented by the “Soviet Academy of Sciences.” This fiction was propagated to maintain the secret status of the organization tapped to help the Indians build the satellite, Yuzhnoye. In fact, so secretive were the Soviets that Yuzhnoye’s chief designer Viacheslav Kovtunenko was identified simply as a professor at Dnepropetrovsk University instead of as one of the leading designers of Soviet missiles.

---

73 This joint project was publicly known as the “Interkosmos” project and led to the launch of more than two dozen satellites into orbit carrying experiments from various Eastern European nations.
74 It is also possible that Iangel’ himself played a role in pushing Yuzhnoye as the Soviet partner. He was apparently friends with K. P. S. Menon, the Indian Ambassador to the Soviet Union from 1952 to 1961.
Between 1972 and 1975, the Dnepropetrovsk team provided an enormous amount of assistance to ISRO in building the satellite. Kovtunenko’s team contributed to choosing the basic design of the satellite, carried out the thermal calculations, and estimated the dynamic characteristics of the object. The Soviet organization also provided a gas jet system for the spin-stabilizing the satellite, solar and chemical batteries, the onboard data recorder, thermal protection systems, and some other equipment. Most critically, Yuzhnoye provided the actual booster rocket that would launch the satellite into orbit and helped Indian engineers track the satellite from a center outside of Moscow. All the work paid off with the launch in April 1975 of Aryabhata, the very first Indian satellite to reach orbit, and so named by Prime Minister Indira Gandhi in reference to the Indian mathematician who lived in the 5th and 6th centuries.\(^78\)

Although the three scientific experiments on board the satellite failed after five days in orbit, this was a big achievement for India and, as numerous memoirs attest, a transformative learning experience for ISRO engineers.\(^79\) Yuzhnoye provided further support for two more ISRO satellites that the Soviet organization launched for India in 1979 and 1981, known as Bhaskara-1 and -2.

**Some (Obviously Underdeveloped) Concluding Thoughts**

The narrative of place in the history of transnational science and technology that I have sketched out here offers one possible way to conceptualize the history of rocketry and space. Here, there is no “Indian space program” or “Chinese rocket program” but a series of moments grounded in sites that witnessed the transnational exchange of knowledge, matériel, and people.

In Thumba in the 1960s, the architects of the Indian space program established an international nexus for scientific and technical exchange enabled to a large degree by key Indian technocrats trained at MIT. Indian space officials also situated MIT in their orbit by recruiting its resources for initial satellite studies. MIT was, of course, the most important educational institution for a large number of Chinese scholars in the 1930s and 1940s, many of whom returned to Beijing to found the Chinese missile program. Soviet help was indispensable for setting up initial production runs of Chinese rockets in the 1950s; many of these engineers and rockets came from the Ukrainian industrial city of Dnepropetrovsk, a site for the largest missile factory in the world. Here at Dnepropetrovsk, in the 1970s, Soviet engineers welcomed Indian scientists and engineers as they jointly developed the first Indian satellite, Aryabhata. Such a narrative articulates one possible alternative model in conceiving a transnational history of science and technology, one that forgets the received conventions of nation, program, and ownership in the hope of making visible (in the words of Zuoyue Wang) the “hidden transnational movements of people and instruments in science and technology”\(^80\).