India & France in Space

(History in Memoirs)

Pranav Sharma, Curator, Space Museum, BM Birla Science Centre, Hyderabad, India

At the Thumba Equatorial Rocket Launching Station (TERLS) (near Thiruvananthapuram, Kerala) Indian Space Program was launched with the taking off of an American sounding rocket called ‘Nike Apache’ on 21 November 1963. Prof. Jacques Blamont [the founder scientific and technical director of National Centre for Space Studies (CNES-Centre national d'études spatiales)] personally brought the rocket based payload from France, called the Sodium Vapour Payload which marked the beginning of rocket based experiments in India. He was also honored with a Padma Shri by Government of India in 2015 for his contribution to the Indian Space Program.

Eknath Vasant *Chitnis*, an Indian space scientist and a former member secretary of the Indian National Committee for Space Research (INCOSPAR) wrote in his memoir, “...I went to France and...talked to people. We had thus the international collaboration in the offing. The French gave us radar, which we upgraded. Then we had the chaffe experiment for winds and sodium vapour experiment. Then the Germans came with barium payloads and then the Japanese came with X-ray astronomy payloads. Bhabha asked Vikram and me, before that seminar in January 1963, ‘What should I say?’ He wanted to have some brainstorming with us. So we said, ‘This is now the beginning of 1963. In 1957 the space era started and India as a country should go in for applications and build technology of rockets and satellites...”

P V Manoranjan Rao, a veteran space scientist remembers, “...In his now famous ‘A Profile for the Decade 1970–1980 for Atomic Energy and Space Research’, Vikram Sarabhai noted, ‘It was clear at the outset that space research could not progress without the simultaneous development of advanced space technology. As a beginning, an arrangement was concluded in 1964 to manufacture in India, under license from a French firm, a two-stage rocket capable of reaching an altitude of about 150 km with a payload of approximately 30 kg. The manufacture of these rockets was established provisionally at the Bhabha Atomic Research Centre pending the setting up of a special Rocket Fabrication Facility (RFF) at Thumba. A Rocket Propellant Plant (RPP) was also set up at Thumba to make solid propellant blocks under license from France.’ The rocket in question was of course, the Centaure whose Indian version was designated as Centaure II-B. The French firm was Sud Aviation. Of the eighty-one Centaures launched from TERLS during 1965–88, only ten were imported. The rest (Centaure II-B) were manufactured in India. The lasting contribution of the Centaure Indigenisation Programme was the establishment of RFF and RPP, which still stand today at Thumba as sentinels to Sarabhai’s vision. The experience gained through RPP in producing propellant grains for the Centaure II-B contributed significantly to the R&D efforts of ISRO in mastering solid propellant technology. Similarly, RFF introduced our engineers to 15CDV6, a low-alloy, high-strength steel. Thus, thanks to the Centaure Indigenisation Programme, our engineers could understand the morphology of 15CDV6 and study its welding and heat treatment characteristics. This is important because 15CDV6 is used extensively in launch vehicles of ISRO...”

During the years when solid propellant for Indian rockets was under study simply because it was easier to build a solid propellant motor than for a liquid propellant, Madhavan Pillai Ramakrishna *Kurup* (an Indian rocket scientist and the founder of the first solid rocket propellant plant in India at the Vikram Sarabhai Space Centre) and M.C. Uttam were trained in France where they got brilliant exposure to the manufacture of free-standing PVC propellant grains. “Thus the whole ambience at that time was suffused with solid propellants!”, says Suresh Chandra *Gupta*, a pioneering space engineer and former director of Vikram Sarabhai Space Centre at Thiruvananthapuram, Kreala.

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“...for the manufacturing of the RH-75 Rohini sounding rocket requisite facilities were acquired for mixing, casting and curing them for use. The whole rocket weighed less than 7 kg. Ultimately, the rocket was put to instrumented flight test. The in-flight acceleration was measured with a strain gauge type accelerometer and the chamber pressure was measured with a strain gauge type pressure transducer, similar to the one used in static tests… the Cotal Radar, gifted by CNES, France, tracked the flight in skin mode. Close match between pre-flight predictions and in-flight measurements established that the Rohini Group had achieved the capability to design and realise hardware and even more significantly to develop software for prediction of performance. The multidisciplinary team had begun to perform well...”
- Suresh Chandra *Gupta*, former director, Vikram Sarabhai Space Centre at Thiruvananthapuram, Kreala.

Kalam remembers, “...Blamont of France, and NASA scientists. They were all there sitting through day and night as we were integrating their payloads into the tiny rockets. Mechanical and electrical integration, attending to the scientists’ requirements, the flight qualification of payloads and rockets, and exploring new areas of understanding were all providing day-to-day adventures and challenges...”

DPS-4 (Development Project for Stage-4): A Unique Experience in Systems Thinking
- APJ Abdul Kalam, Senior Space Scientist and Former President of Republic of India

DPS-4 was unique in many respects: both in technology and management. Engineering the stage as a part of the total vehicle, evolving specifications and design of the subsystems and planning for the realisation as well as qualification of the components, subsystems and stage were all challenging. The collective wisdom of the team was fully exploited to do literature survey, to brainstorm, to plan experiments, and to evolve concepts. A matrix management structure was evolved.

As my team was working on the stage 4 of SLV, Sarabhai brought a French visitor. This gentleman was Hubert Curien, President of CNES, our counterpart in France. They were then developing the Diamont launch vehicles. Curien was a thorough professional. Sarabhai and Curien together helped me to set a target. They also cautioned me about the possibilities of failures. Sarabhai’s catalytic intervention led Curien to interpret his own progress in the Diamont programme. He brought smile to Sarabhai, when he enquired if we could make the Diamont’s fourth stage. We reconfigured and upgraded our stage from a 250 kg, 400 mm diameter stage to a 600 kg, 650 mm diameter stage. After two years’ effort, when we were about to deliver it to CNES, the French suddenly cancelled their Diamont BC programme. However, later R.M. Vasagam, Project Leader of APPLE (Ariane Passenger Payload Experiment), India’s first communications satellite, brought smiles to us when he flew the SLV-3 fourth stage as apogee boost motor for APPLE, which was launched by the Ariane vehicle.

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The Birth of Vikas Engine
(Memoir of N. Narayanamoorthy, Senior Advisor, Launch Vehicles in VSSC and Chairman of Launch vehicle Flight Readiness Review for PSLV programme)

ISRO entered into an agreement with the French Space Agency (CNES) under which: (1) ISRO would supply 10,000 space-qualified pressure transducers to CNES and (2) in return, France would transfer know-how for their liquid engine, Viking, to ISRO. The indigenous version of Viking is called Vikas.

...The second and fourth stages of PSLV are powered by liquid propulsion. As already mentioned, the basic know-how for the second-stage engine, Vikas, was obtained from France. Yet, to translate engine design into the fabrication drawings and to identify the materials and processes associated with the realisation of component parts like gas generator, turbo pumps, gas bottles, the pneumatic and hydraulic system, etc., really posed many challenges. Industries were roped in and for some critical technologies in-house workshops were utilized and the first engine was realised towards the end of 1989.

As our own test facility at Mahendragiri was not ready, this engine was taken to France and tested at the SEP (Société Européenne de Propulsion) facilities. It was really heartening that at the very first attempt, the engine performed satisfactorily. At that time, the basic test facility for the large thrust rocket engines was being established at Mahendragiri, very close to Kanyakumari, in Tamil Nadu. The stage test stand was also established later at Mahendragiri. This involved large structures which could withstand the thrust of the engine as well as the weight of propellant tank. The facility was completed by establishing a network of instrumentation and control systems.

ISRO–SEP Agreement
(Memoir of A.E. Muthunayagam, Founder Director of Liquid Propulsion System Centre)

The really major breakthrough in liquid propulsion systems came in 1974 when ISRO signed an agreement with the SEP of France. At that time the French were developing the Viking liquid engine for their Ariane launch vehicle programme. Without any transfer of funds, this agreement provided for technology transfer from SEP to ISRO for pressure transducers and Viking liquid engine. In return, ISRO would produce and supply 7,000 pressure transducers to SEP, and also spare the services of 100 man-years of ISRO engineers and scientists to SEP for their Ariane launch vehicle development.

To acquire the Viking engine technology, our engineers worked in all areas of development activities of the Ariane programme. They participated in design reviews, progress reviews and even had interaction with European industries. They received all detailed design drawings and documents. They participated in inspection and quality assurance of systems, subsystems and components. They also participated in assembly and integration, checkout and testing operations in SEP facilities. They had discussions with SEP specialists and received clarifications to understand the technology fully. The technology acquisition programme was successfully carried out under the leadership of my colleague S. Nambinarayanan. Around forty engineers, covering all areas, participated in the technology acquisition programme. On behalf of ISRO, the agreement was signed by T.N. Seshan, then Additional Secretary of DOS (Department of Space) who coined the name Vikas to replace Viking. (Seshan later became the high-profile Chief Election Commissioner of India.) Vikas in Sanskrit means'development' and also 'flowering'. Vikas is also an acronym for Vikram A. Sarabhai. In any case, that was how the Vikas Project was born to the advantage of both France and India.

Remembering APPLE
(Memoir of RM Vasagam, Project Director-APPLE, India's first indigenous geostationary communication satellite project)

… APPLE was designed and built as a sandwich passenger-carrying Meteosat on top and CAT (Capsule Ariane Technologique) module below…

… In case the flight model of APPLE was not ready in time, we were to launch the flight-worthy structural model stored at Toulose, after composite stack test, which would be returned to India only after the launch. What a shame it would have been if we had not delivered the flight model on the agreed date? We also had to set up an independent safety office in ISRO. We did the coupled loads analysis for the first time! Transporting of solid apogee motors on aircraft and its storage in France, moving it to Kourou later, transporting Indian-made hydrazine to Kourou by ship, etc., were things accomplished against great odds. Air India had been our carrier but at a critical moment we were facing difficulty of getting the chartered aircraft to come to Toulose to carry the spacecraft to Kourou owing to violation of Lomé Convention of 1975. Kourou being a French overseas territory, we had to engage Air France!…

Indo-French Cooperation in Space Technology
(MYS Prasad, Former Director of the Satish Dhawan Space Centre)

The cooperation between India and France in the field of space research and applications of space technology had its beginning in November 1963, when a sodium vapour payload provided by the Centre Nationale d'Etudes Spatiales (CNES) was flown on a Nike Apache rocket from the Thumba Equatorial Rocket Launching Station (TERLS). The Indo-French collaboration in space research was put on a formal footing through a Memorandum of Understanding (MoU) signed in May 1964 between the CNES and the Department of Atomic Energy (DAE). Subsequently, CNES gifted a variety of equipment including COTAL radar to TERLS. CNES also helped in concluding agreements with the French aerospace industry to manufacture rocket propellant and also to manufacture Centaure rockets in India under licence. The CNES has also provided specialised training to a number of ISRO engineers and scientists every year.

In April 1972, an agreement was reached between the Indian Space Research Organisation ISRO and CNES to establish a joint commission to initiate and follow up cooperative programmes. Beginning in 1973, the ISRO-CNES Joint Commission met regularly every year and had acted on the recommendations of the joint working groups in various specialised areas such as launchers, telecommunications, remote sensing, etc.

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Under an agreement with a French company, Société Européenne de Propulsion (SEP), ISRO acquired some important aspects of liquid engine know-how. In return ISRO supplied expert manpower for specified man-years and also produced pressure transducers for SEP for use in Ariane launch vehicle. In May 1975, CNES expressed the desirability of widening the scope of the Indo-French collaboration by concluding an intergovernmental agreement in place of the existing inter-agency (ISRO and CNES) agreement. The Indo-French agreement on cultural, scientific and technical cooperation signed in June 1966 and that signed in April 1972 for setting up the ISRO-CNES Joint Commission were the basis for the intergovernmental agreement. It laid the groundwork for pursuing joint programmes, exchange of information and personnel, etc., for space research and application of space technology for peaceful purposes.

One major cooperative experiment with French space agency was the conduct of joint experiments utilising the Franco-German satellite, SYMPHONIE. Under this, ISRO and the Post and Telegraphs Department of the Ministry of Communications jointly worked on ground experiments. Besides, there were exchanges of scientists between the two countries for training, discussions, workshops and related items.

The Indian Space Research Organisation had also procured substantial equipment for the space programme from French companies. Examples are guidance-system-related equipment for the launch vehicle project, television camera for Bhaskara and components and equipment for the SYMPHONIE experiment. Those contracts more or less were on a commercial basis though the good offices of CNES were also utilised. Similarly, some of the test facilities existing in France were utilised by ISRO for conducting special tests. Valuable commercial contracts were signed later with the companies like Thomson, SAFT, Matra, Deutsch, SAGEM, etc.

CNES and the fledgling Arianespace offered a payload opportunity for the third flight of Ariane 1 (V-3) to be launched in 1981. ISRO proposed a small communication satellite called Ariane Passenger Payload Experiment (APPLE) against this announcement. APPLE, the first three-axis stabilised communication satellite, was designed and realised in India. APPLE was successfully launched by Ariane 1 (on its third flight) in 1981. Subsequently, India decided on the INSAT system of multipurpose geostationary satellites. Ford Aerospace, a US company was selected through search on an international basis for fabrication and supply of INSAT-1 series of satellites to ISRO's specifications. ISRO team worked as the project management team at the satellite fabrication facilities. INSAT-1A, 1B and 1C were launched using launch vehicles of the USA. This chilled the relations between ISRO and CNES/Arianespace in the 1970s. However, with the launch of INSAT-1D in 1988–89 using Ariane launch vehicle, the differences were ironed out. Subsequently, Arianespace had long successful commercial contracts with ISRO for launch of many INSAT series of satellites.

The most important features which glaringly come out of the cooperation between ISRO and CNES are the following:

Acquisition of Vikas engine technology by ISRO through the agreement with SEP of France. This engine had become the backbone for the launch vehicles of ISRO. The telecommunication application project with SYMPHONIE satellite laid the foundations for using satellite-based communications in India. This along with educational TV experiments using Application Technology Satellite (ATS) of the USA was the foundation onwhich the applications of INSAT series of satellites had grown in India.

The initial seeds of cooperation were laid by scientists from both sides, which gradually led to the agreement between ISRO and CNES, and finally resulted in a governmental agreement between India and France for the cooperation in space activities. The cooperation between ISRO and CNES also led to very valuable aerospace trade between French companies and the centres of ISRO.

The initial cooperation in the launch of APPLE on Ariane launch vehicle, free of cost, led to a very good commercial relationship between ISRO and Arianespace for launch of INSAT series of satellites starting with INSAT-1D. The essential feature of the cooperation between India and France was to gradually mature the assistance into cooperative actions and then to commercial contracts.

Courtesy: PV Manoranjan Rao