Finally, India’s space history reached a major milestone on January 5, 2014 when the GSLV Mark-3 rocket equipped with an indigenous C-2.5 cryogenic engine successfully launched the 1983 kg satellite dedicated to the GEO synchronous transfer orbit (GTO). This was the first ever successful launch of a spacecraft from Indian soil using an indigenous cryogenic rocket engine. As the GSLV Mark-3 rocket soared to the skies and back to earth, the mission embodied a significant milestone in India’s spaceflight program.

Gaganyaan
Time to Get Back to Work

WHILE THE INDIAN SCIENCE COMMUNITY WAS EAGER ON TAKING THE PROPOSAL OF HUMAN SPACEFLIGHT FORWARD, THERE WAS SOME INITIAL CONFUSION REGARDING THE ROCKET WHICH CAN BE USED FOR LAUNCHING SUCH A HEAVY MANNED SPACECRAFT INTO LOW EARTH ORBIT. HISTORY SAYS THAT THE UNITED STATES HAD USED THE TITAN-2 GLV ROCKET WITH A LIFTOFF CAPACITY OF 3500 KG INTO LOW EARTH ORBIT FOR LAUNCHING MANNED Gemini CAPSULES WITH 2 CREW MEMBERS.

NDT-4 government accorded cabinet nod

While the Indian science community was eager on taking the proposal of human spaceflight forward, there was some initial confusion regarding the rocket which can be used for launching such a heavy manned spacecraft into low earth orbit. History says that the United States had used the Titan-2 GLV rocket with a lifting capacity of 3500 kg into low earth orbit for launching manned Gemini capsules with 2 crew members. Such a feat was achieved by the United States of America during the 1960s. China has reportedly reversed engineered the Russian manned 3-seater Soyuz capsule which has resulted in the Shenzhou programme taking shape and maturing during the last three decades. India’s GSLV Mark-3, which is equipped with an indigenous C-2.5 staged-combustion based cryogenic engine yielding 73.5 kilonewtons of thrust in vacuum, is potentially capable of being used for such missions provided ISRO manages to design a minia
turised-2-seater spacecraft. By the end of the term of the worthless UPA-2 government, there were talks of a prospective Indian strategic tie up with Russia for the transfer of Soyuz spacecraft technology to India for the manned mission. But the deal never materialised.

The success of the CARR mission in 2013 changed all dynamics and the Indian scientific community got the...
confidence to launch the ambitious manned mission onboard a GSLV Mark-3 rocket. The indigenous CE-20 gas-generator based cryogenic upper stage engine of GSLV Mark-3 yielding 290 kilonewtons of thrust in vacuum, is potentially capable of launching a heavy 3.6-tonne manned spacecraft to LEO. As the new rocket underwent two more developmental flights in successive years, it was finally selected by ISRO for launching the human mission.

The NDIA-2 government led by Prime Minister Narendra Modi finally accorded the much-awaited union cabinet approval to India’s human spaceflight programme on December 28, 2018 and formally made it a national mission, thereby clearing the final bureaucratic hurdle. The union cabinet also simultaneously approved a whopping 10,000 crores for the dream project, to be spent in phases over the next 3 years. The project officially christened ‘Gaganyaan’ is slated to launch a 3-member crew to LEO for a week-long mission by 2022, when India celebrates the 75th anniversary of independence from British rule. ISRO also carried out a successful Pad Abort Test (PAT) of the Crew Module on July 5, 2018, a few months before the union cabinet approval of the programme.

Design of the manned spacecraft
With ISRO developing a highly durable and robust 3735 kg atmospheric re-entry vehicle (crew-module) for bringing back the crew back safely, system plans for developing a separate 3000 kg service-module have also been finalised. The service-module will be mated with the crew-module and both will have a combined gross launch weight of around 7800 kg (including fuel and other supplies), thus forming the orbital-module. The service module will also be equipped with two liquid-propulsion engines for gliding through the vacuum of space and orbital correction. The spacecraft will be equipped with life-support and environmental control systems and with emergency mission-abort and emergency-escape systems which will enable the crew to handle all continued.

Almost 11 metres per second when the spacecraft finally splashes down into the sea. A set of retro-rockets installed under the crew-module will cushion the landing of the capsule. As the landing-zone has been designated in the Bay of Bengal, the crew-module will be armed with a balloon-based floating mechanism which will prevent it from sinking until Indian Navy’s Coast Guard ships locate the point of impact in the ocean and recovery teams are immediately redirected towards the exact landing-zone. Some of the systems, subsystems and manoeuvres, which will be used in the manned mission, have already been successfully tested during the CARE mission of 2014 that included orbital injection, separation from launch vehicle, atmospheric re-entry procedure, capsule separation, heat-shields and aero-braking systems, deployment of parachute, retro-firing, flotation systems and procedures to recover the crew-capsule from a remote area in the Bay of Bengal.

Preparations in full swing
While the basic foundations of the mission have been laid, the final testing phase of many of the critical components are slated to begin by June 2021, with the maiden orbital flight of the orbital-module (in uncrewed version) also taking place by the end of this year. Meanwhile, ISRO is also in the process of launching two communication satellites under the IDISSL (Indian Data Relay Satellite System) programme, which will aid the manned spaceflight mission after launch. The two IDISSL satellites will provide seamless data communication links between the Indian remote sensing satellites in orbit, the Gaganyaan spacecraft and the ground stations. The new satellites will be placed in geostationary orbit.

The Defence Food Research Laboratory (DFRL) is also developing ‘space food’ for the astronauts which will be consumed during the mission. A prototype ‘Advanced Crew Escape Suit’ (space suit) weighing 5-7 kg has also been developed, tested and performance verified by Sure Shot India (Private Limited based on ISRO’s requirements).

While the Gaganyaan programme is likely to be trained in Russia, simultaneous preparations have begun to set up an Indian Human Spaceflight Centre in Bengaluru. Indian astronauts will be called ‘Vayanaauts’ and will be trained at the ISRO centre in Bengaluru for future Gaganyaan missions. The new 1000 crore centre will impart training to the vayanaauts regarding rescue and recovery efforts, operations in zero-gravity environment and monitoring of radiation environment. ISRO has also signed a Memorandum of Understanding with the Institute of Aerospace Medicine (a prestigious institution under the Indian Airforce) for conducting research on the psychological and physiological needs of the crew, development of training facilities and the development of space medicine.

Meanwhile, as of January 2021, the first batch of four vayanaauts (including the mission commander) is undergoing their year-long training programmes at the Gagarin Research & Test Cosmonaut Training Centre (GCT-C) in Russia. For obvious reasons, the first batch of vayanaauts consist of Indian Airforce test pilots. ‘Airforce test-pilots are perfectly fit for the Gaganyaan job as they have a very good knowledge and first-hand experience of different gravity environments and can face challenges in the skies due to their flying skills’, says Flight Lieutenant Arvind Sharma, a recently retired officer of the Indian Airforce. ‘The task of training the initial batch of vayanaauts have just begun. If all goes as per plan, female vayanaauts can also be accommodated in successive Gaganyaan missions in the very near future’, confirms Yash Gaba, a former scientist at ISRO’s Vikram Sarabhai Space Centre.

Deep space rendezvous dreams
While the Gaganyaan programme will be an ambitious beginning for the ISRO, the interstellar journey to the next destination (Earth’s gravitational forces are ready to be explored with manned spacecrafts in this century. Indian manned lunar landings and further exploration (flyby and landing missions) of Mars and Venus and asteroids in the distant future. After the inner solar system is explored, ISRO may eventually set its goal on exploring the realms of the outer solar system in the latter half of the current century. ‘Naturally, as ISRO starts sending manned missions to LEO, an orbital docking with a space station followed by a lunar human landing are the next logical steps in this direction. It is good that the government has now opened up this sector to large-scale private sector investments. There are already ongoing discussions towards the full-fledged involvement of the private sector in the industrial production and launching of PSLV rockets. But more needs to be done. The country needs a brand-new outer space policy initiative as well. India needs to be ready by the time the next generation of vayanaauts come up’, says Sanjay Bathe, Founder of Space Development Nexus (SDN), a collaborative platform for academia, entrepreneurs, technocrew and aerospace researchers. With a decisive, strong and visionary union government led by Prime Minister Narendra Modi at the helm of affairs, ISRO can always take giant leaps into the future. The potential is enormous and distant horizons beyond the earth’s gravitational forces are ready to be explored with manned spacecrafts in this century.

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