

The Indian Human Space Programme

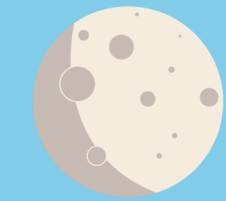
Past, Present and Future

Aerospace Medicine

Aerospace Document: Milestone 2018

Conceived by

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The Indian Human Space Programme

Past, Present and Future

The Roadmap for Aerospace Medicine; an integral national resource to support Indian Human Space Programme

Recommendations of Stakeholders: Document: Milestone 2018

inspired by

“AVM MM Srinagesh Memorial Oration”
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This document is conceived in Aug-Sep of 2018, by Air Vice Marshal (Dr) Pankaj Tyagi, VSM, (Retd), IAF and is presented, as the thoughts flew and formed words. It is not in any formal format. It is just a small step to convey thoughts, on a matter of national importance to the few stakeholders of India.

It is a small effort to share the burden of those who take decisions for our nation, that changes destiny of its people. It is an admiring tribute to Space Commission of India and Prime Minister Narendra Modi.

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APPENDIX 2 - Indian Human Spaceflight Programme: Recommendations of National Committee

1. Preface

Creating ability to take Human in Space: Creating wings for the spirit of India

When a capable and competent nation is denied the opportunity to be part of a creative effort, due to and only because of lack of economic resources, it creates a subconscious resolve to do it right, when the right time arrives. The resolve becomes even more intense, if the denial rides on the sustained destruction of original creation of material and Intellectual resources by its people. The desire to succeed and show the world, who you really are, then, unknowingly becomes part of its character. We in this part of the subcontinent have inherited this character to succeed, come what may, against all odds, only, to create. Putting man in space gives us that opportunity to put India back on track. The time now is right for our nation to walk into space against all odds. The decisions taken by the stakeholders at “Milestone 2018” on the road to put Indians in space will do much more for India than merely walk the path where many have trodden. The creation of this ability to go to space, come back and go again at our pace and will is worth putting in the vaults, once the awakening of the spirit of real India, takes us on the path to new materials, technologies, computing resources and intellectual wealth. But this time, the safety of the spirit of India must be secured forever. What lies in the vaults will give us that protection, not to be enslaved again and ever.

When the sociopolitical, technological, economic abilities are right, then what transforms the moment into a milestone is one man’s resolve to take the bold step. Mr Narendra Modi, the Prime minister of India is that man. The moment is here and now. To put aside money for Indians to go and conquer space is that step. This decision will ignite minds and liberate 1.3 billion people from the shackles of poverty, ignorance, denial to create and dream. It will deliver India back to the path, where it started 5000 years ago, to a universal civilization as big as the universe itself. Only a country like India can do this. Just for this reason India must put Humans in space.

2. Human Space Programme of India

Ingredients for the National Programme

To make it a well-conceived programme, we are now able to do gap analysis and identify the areas, in which we need to work, keeping the mission objective in mind. To drive a national programme of such magnitude, the following ingredients are essential, which now are available:

- A dynamic Leader who can inspire to instil in the country
 - A fervent desire
 - A strong belief
 - A national will
 - A clear realistic vision for next 50 years
- Material resources
- Intellectual resources
- A strong command and control centre
- A source document that is time dynamic

3. Aerospace Medicine

The Background

On 20 Jul 69 Neil Armstrong had landed on the moon. Since then, I have spoken on, why we must build capacity, to put Humans in Space, about Space Accidents, Life Support Systems, Romance with Space and its realities, at various forums like IAM, ISRO, Air HQs, DEBEL, Conferences, Working Groups and after retiring from service, with aviation & space related industries. I was always very clear in my mind on matters of space, till I started preparing this oration. I and many of my colleagues were suffering from wait fatigue. Waiting for a go ahead for human in space programme by India. We were all ready and primed up in 2009 and since then we have been waiting.

Two failures of GSLV and aerospace medicine went out of focus of the stakeholders, the space programme management group, as a vital resource for the planning and execution of human space missions. Why didn't the programme managers ask the aerospace medicine to continue to walk with them in the preparations for human rating of the systems, while they rectified the fault lines of the launch platform. Why should such a thing happen? We set our pursuit back by many years just by not being kept in the loop. It is a matter to think about and debate. The question is "Why should we not have our own mechanism to 'Programme Manage' Aerospace Medicine, its Engineering and Operations, similar to ISRO?"

I realised that the discussion on the subject of "Past, Present & Future" of this human space programme, with a very informed audience, who have themselves, helped to walk past many a milestone and are considered leaders in aerospace medicine, must be effectively used, to policy assist India's very ambitious, but genuinely required programme. Therefore, the effort is to let decision makers know of our strengths and weaknesses. I request for your application of mind on this, to bring in the changes in the existing mindset. 'Review' leads to evolution, with time. It is essential for success of any concept. Rigidity of mind, inflexibility of organisations is the last thing, that is required, when chartering a new path.

We need to refocus the attention of the country, on how 'aerospace medicine' and related operational resources can contribute, in putting humans in space. We do not claim, that we have all the answers, but we know, that we are the best students, who can and will master the "art and craft" of designing, planning and executing the brief, of keeping the human, safe in space, as we have done in aviation for a long time.

The selfish interest is of course, the yearning to learn and be part of this opportunity, which many of us thought will not come during our lifetime.

I urge all of you, the worthy ambassadors of medicine, engineering and operations to be part of nation building in this new area of work. You must give an insight, to as many of the decision makers, as possible, into, what this field can achieve for the country. Let the lights come back on 'Operational Space Medicine' very subtly, through your past work and your technical wisdom, to make space medicine deliver.

Also, like other agencies, we should also have a special wing to manage media well. It should aim to keep the balance right and help India reach its goals. Institute of Aerospace Medicine must expose part of itself and its work, to the civil world, as I feel, its strength can now be used to leverage, strategic relations of India with other countries.

4. Why shouldn't the world know?

A glimpse of aerospace medicine work

Why shouldn't the world know?

- That we were the first to transmit ECG on phone wires from IAM to Command hospital Bangalore in early sixties of previous century, earlier than the American claims.
- That real-time telemetry monitoring ECG from the fighter cockpit was done on our own, at this institute, in late seventies by our own scientists.
- That vector cardiograph experiment was designed and taken into Soyuz crew module, to monitor Rakesh Sharma by our own people.
- That first water-cooled suit was made and tested by a gentleman sitting in this audience.
- That the first G-X axis acceleration were made and used in our own acceleration department, on an old German centrifuge.
- That first time HBO chamber environment gas monitoring, was done through real-time sampling, long time back, by one more gentleman sitting in this audience.
- That we were the ones who designed, gave specifications, selected the industry partner, fabricated, installed and tested the modern altitude simulation and hyperbaric chambers against British and US standards. We created human rated chambers and used them, surprisingly, from the funds given by our own office of DGAFMS.
- That we brought in the manual and electronic control systems for controlling ascent and descents, all made in India. It took us nearly 10 years.
- That we made our own instruments to collected data to calculate the heat loads in fighter cockpits in summers of Jodhpur, Suratgarh and Jamnagar.
- That we created Static Anthropometric Platform to make 3-D maps of various cockpits on ammonia prints, without any computers.
- That we measured human muscle strengths through our own designed accelerometers.
- That we designed and tested first Indian G- Valve on our own.
- That we created anthropometric nomograms of Indian ethnic groups to give inputs for cockpit designs.
- That we created nomograms for heat loads in Indian population.
- That we gave the experimental protocol for highest and lowest percentile dummies to HAL & ADA for real Dummy Ejection from a dual ejection platform and conducted the tests in England. This gentleman is also in the audience.
- That we gave human engineering inputs for LCA cockpit design base on which the front panel was shifted by 4 mm.
- That we assessed all aircraft cockpits, after the aircrafts were bought, to fit in the Indian Pilot population. This gentleman is also in the audience.
- That we put a young man suffering from Acute Myeloid Leukaemia back in civil cockpit, changing the ICAO rules and cases of Thalassaemia Minor, back in fighter cockpits, by evidence-based practice of aerospace medicine.

- That we were the first to get the real computer, now lying in our museum. We created RADAR simulation software through basic language, with the help of a lady scientist from Institute of Sciences.
- That we conceive and executed world class OPTRAM training. Many of them are today part of this audience.
- That we worked out and documented everything related to putting human in space, 10 years back and gave these documents to ISRO.
- We created training experts and teachers in Disorientation, Acceleration, Night vision application. Many of them are now teaching abroad.

The list is endless. I can fill books on this...
Why shouldn't the world know?

It is recommended that funds and policy support be provided for IAM to open its "Aviation and Space Medicine Museum" gates to inspire and educate the people, similar to HAL's Heritage Museum down the road.

5. The decision

Courage of Conviction and integrity of intent

I wrote to Prime Minister Narendra Modi in Jul 2018, giving my views on why we should go for Human in Space programme. I communicated with Pallava Bagla and through him with Dr Jitendra Singh, Dr Sivan, Dr Umamaheshwaran and Dr Lalithambika.

Some of you sitting in the audience would remember, when speaking to you in the millennium year, I had said that “in near future more people will live in space than on earth and moon will be colonised within the next century”.

We are now crossing the 18th milestones of this 21st century and today, I can share with you that China, having made its intentions known, will colonise moon by 2030, Americans will walk on the Mars soon, Russia, Europe and Japan will be part of huge space programmes. Intent and signs of weaponisation of space have already started being felt and seen. India has no choice but to move into its “Space”.

The existing footprints on cislunar space, moon and mars, created by Indian Space Research Organisation (ISRO), would also help in taking our people to suborbital missions first, then help build capacity to erect and live on our own space station and finally to colonise moon.

Efforts of wise leaders and visionaries of the Space Commission of India, the creative bureaucrats, the technocrat czars, the industry leaders, the great scientific community and the fine institutions, spread over a time frame of nearly eighty years, have contributed hugely in the success of space programmes.

More than all, the courageous, integrity of intent, shown by the “lonely on top” political leaders, in nudging the destiny of India, can only be appreciated in awe. The courage of conviction of Mr Narendra Modi to embark on this difficult journey, full of risks, will be one of the turning points for India, in this century.

6. The decision makers

Space Commission of India

The Space Commission of India is constituted of following 9 specialists namely:

1. Dr. K Sivan (Secretary, Department of Space) Chairman,
2. Shri. Nripendra Misra. (Principal Secretary to PM) Member,
3. Shri. Ajit Doval. (National Security Advisor to PM) Member,
4. Shri. Pradeep Kumar Sinha, (Cabinet Secretary), Member,
5. Shri. Vijay Keshav Gokhale (Foreign Secretary) Member,
6. Shri. Hasmuk Adhia (Finance Secretary) Member,
7. Shri. A. S. Kiran Kumar (Vikram Sarabhai Distinguished Professor) Member,
8. Ms. Sanjeevane Kutty (Secretary to GOI) Member (Finance),
9. Prof. Goverdhan Mehta (National Research Professor) Member,
10. Shri. Anoop Srivastava (Joint Secretary & FA, DOS) Secretary

This hugely talented group is responsible to the Prime Minister, on many matters of national importance, one of them is Space and now, also, the Indian Human Space Programme. Through this Srinagesh oration, I salute them and thousands of their unknown, but special team members, who work so hard behind the scenes and help turn dreams into reality.

D-day is flagged as 15 Aug 2018; the day Prime Minister announced his intent to put Indians in space. The debate of whether, to have human in space or not is therefore over and rests forever. The target set for first launch is 2022 or earlier.

When the burden of responsibility is put on few, the best comes out of them and new paths get chartered. We are very proud and fortunate to have such people, on whom these responsibilities can be passed with confidence. Aerospace medical community should get inspired by such leaders and develop its own leadership through, not only being a domain expert, but also develop expertise in project management, finance, geopolitics, creation of strategic goals and soon be part of the commission.

7. Human Space Programme: Truly a national programme of India

Enormity of a National Programme

This brings me to the enormity of what a “National Programme” could be. Each one of us, must understand, the scale of the effort and how we are just a clog in the enormous wheel. Our contribution to this effort is vital, but the wheel will move on, irrespective. Therefore, the timelines and milestones that I will cover in this paper are too small in the large canvas of our national progress, yet they are the landmarks, that make us proud. Without small steps no one can embark on a long journey.

Starting from the borrowed Sounding Rockets transported on bicycles to launching of GSLV III is an effort no less than a miracle, created by ISRO workforce, for a country like India, which is still struggling to get up and walk its 1.3 billion people from poverty to prosperity, while yet willing to pay the cost of staying the path of democracy. ISRO centres, 40 of them, are now located at 24 cities across India.

The success of ISRO, in no less measures, also rests on wisdom and solid backing of PMO and Space Commission of India, compared to many other programmes, who do not have such direct access to decision makers.

ISRO has credited many public sector organisations, private industries, foreign space organisations and Institutions, for their help in its national efforts for non-human rated projects. This was done through signing of Memorandum of Understandings or MOUs, that probably was right for a time. The MOUs are time bound, specific, rigid, legal and in majority of cases commercial documents, where one organisation is trying to reach certain specific targets. They do not form long term relationships. They do not form teams. It is a document or a process to transact. Once it is over, there is no commitment left except of signing one more MOU, if any mutual benefit is visible. National Projects need both MOUs and amalgamation of multiple brains and isolated pockets of excellence, on a common platform, where the same goals are set for the whole team and same resources are made available to all, without artificial barriers that individuals and institutions build to remain focused on smaller goals.

A new professional body like Indian National Aeronautics and Space Administration (INASA) similar to say, European Space Agency (ESA) or Chinese National Space Agency (CNSA) or National Aeronautics and Space Administration (NASA) will be required, as the civilian programme expands to include all national resources, for a long-term space programmes and not just a few flights. ISRO should not be burdened with this additional administrative and management responsibilities, lest their manpower resources defocus, from excellent technical work that they are engaged in, for past many years.

While ISRO backed through finances and hand holding by Space Commission, was walking on that path under Vikram Sarabhai, seeds were sown, at nearly the same time, by laying the foundations of School of Aviation Medicine (SAM) later called Institute of Aerospace Medicine (IAM), backed through finances and hand holding by Indian Air Force (IAF), to fill a very niche field of aerospace medicine, under MM Srinagesh, in whose honour, I deliver this oration.

The success of aerospace medicine from the days of bullock carts moving the chambers; operating from a small hut, to what you see today, belongs to all those, who have built it brick by brick with very limited means. It is now admired and acknowledged by USA, Britain, Europe, Russia, Middle East and other neighbouring nations and is known to deliver world class conceptual, operational and administrative processes in the field of aerospace medicine.

For aerospace medicine, IAM is not a physical entity but has become synonym of the whole field of aerospace medicine, through the spread of its intellectual resources across India and abroad. Very humbly but genuinely, we can be proud of this humongous effort.

Thanks to Srinagesh and likes of him to have been part of this journey, which has just begun and is yet to cover many a light year in future. Eighty years of past time frame is therefore a dot, on the timelines, that moving into space has opened for us.

Both, ISRO & IAM have delivered equally in the service of the nation. Whenever since 1947, the nation has asked to rise and deliver, in the field of aerospace medicine, IAM, IAF, has done so with quality control acknowledged by both NASA as well as Russian Space Agencies.

Time has now come for IAM, to split its military and civil responsibilities. Land and resources must be provided by the stakeholders, to gradually form its civil wing as Human Engineering and Life Sciences Institute of Aerospace Medicine. Similarly, Aircraft and Systems Testing Establishment (ASTE), IAF must create a civil wing covering Space Operations. It should also be the seed point of conceptualising the “Operational Squadron of Astronauts” in India.

This green signal to put human in space have raised the stakes for all those involved in matters of space. Till now, ISRO and IAM have walked two different paths, one of pursuing excellence in non-human rated launch pad platforms and programmes not involving humans, the other in selection, part training of astronauts and few steps in operations of life support systems, mainly in high performance aircrafts.

Space Commission needs to quickly upgrade the available resources at IAM and Indian Air Force need to work out and dedicate minimum work force, to at least, achieve minimal required levels of competence, for this larger programme. I recommend forming another mini advisory body within the Space Commission on matters related to Space Operations, Aerospace Medicine, Engineering and Human Factors Programme Management.

We, for smaller reasons, should not hold our people and resources back, at this point of time, the Milestone-2018, where the opportunity is available to surge medicine, flying, engineering and operations forward in a special domain of space travel, space station and moon habitation.

I also understand, that the infrastructure resources of aerospace medicine, available in the country, will indirectly contribute in savings of nearly Rs 500 to 1000 crores to the programme, while intellectual resource, in terms of specialist pool would be priceless. The cost saving and contribution in operationalising the programme through existing and future resources of Ministry of Defence will be huge.

Chief of Air Staff and Air HQs understand the significance and nuances of space. They, wholeheartedly, have made available this resource to the Space Commission. Aerospace Medicine, has always remained indebted to this leadership for being deeply involved and for holding its hand, never seen anywhere else in the world.

Meanwhile, the progress claimed to be made by ISRO in number of human related areas needs to be shared and integrated completely with IAM and aerospace community for the success of the programme.

8. What we have and what we need.

Critical and Non-Critical technologies and resources for Human in Space Programme

A committee is also required to be formed immediately, to list out Critical & Non-Critical needs in the following domains, each one of which will need an aerospace medicine and human engineering input to make it right:

- Human Rated Launch Platform
- Logical Presumptions to set goals for first few Flights
- Crew Module
- Service Module
- Orbit and time in space
- Safety Features
- Contingencies
- Monitoring Systems in all phases of space flight
- Launch Pads
- Tracking Systems Facilities
- Selection & Training
- Aerospace Medical Infrastructure Support

The specifications of all the non-critical items should be urgently frozen and passed on to the Indian industry, to make them deliver on time.

There is no choice, but to fill the gaps of critical technologies, with best options available from foreign collaborations, while, simultaneously, making along a road-map, for indigenisation of critical components by Indian industry, in next 30 years. For example, the advanced environment control systems being developed for cars, can be merged with the systems being developed for use in submarines. The new designs need to miniaturise the items, with least weight penalties and then wrapped around the inner walls of crew module, while part of it goes into service module.

Past to Present: Milestone: 2018: The Indian Human Space Programme

All the information being presented now, is available in public domain. Any serious follower of ISRO's programmes will understand the huge divide that exists in "projections" and "reality", of where we stand in our capacity of space technology and space processes. Space operations being glamorous can hide many weaknesses and failures against the backdrop of stunning successes. To those involved in the delivery processes, it is very essential to know these gaps. While creating perception hypes, through media management are very important to inspire people and surge ahead but it is also important to slowly bridge this divide and work quietly and smartly to reduce the knowledge, resources and technology gaps specially when a human is on board the rockets.

I am taking the liberty of a quick exposure of what happened in recent past to bring you to the, Milestone 2018 and find a way forward. This insight is very important for aerospace medicine doctors, psychologists, physiologists and engineers. It is important for them, to pause at each milestone, absorb and gain from these experiences of success and failures and derive their own conclusions. Due to time constrain, I will not stop by the milestones. You can do so in your own time. Details are available with me and you are free to reach me to discuss and share your views.

9. The Indian Human Space Programme

Past Journey of IAM & ISRO

I will now quickly take you through a few milestones both of IAM and ISRO of the past to bring you level with the present. Future, I will leave, in the hands of next generations, as it belongs to them.

IAM Journey

You are well aware of the milestones of IAM, some of them have been compiled. If you reach the milestone of “2009-2012”, you will see large conceptual aeromedical contribution to Human in Space programme, in terms of several documents, covering all aspects of Space Medicine, from designs to Installation to training, that were submitted to ISRO for launch of Human in Space programme. At milestone “2012-2018”, aerospace medicine was totally delinked by ISRO as the MOU with IAM was over and done with. No need was also felt to make us continue and take us to the next step. We therefore continued our academic pursuit for HSP on our own. There were no links with ISRO’s HSP related decisions.

ISRO Journey

If you look at the milestones of ISRO’s journey, related to human programme, you will notice that it was not very smooth for various reasons. At milestone “2006” it was planned to build a crew vehicle that can accommodate 2 or 3 astronauts and human rate its GLSV Mk-II or GLSV Mk-III launcher. The government sanctioned Rs 95 crore to study all aspects of the manned space mission.

At milestone “2007” Space Recovery Experiment-1 (SRE-1) was conducted. SRE-2 was planned but could not be completed due to failure of GSLV in 2010.

At milestone “2008” ISRO called meeting to discuss its feasibility study done for 4 years between 2002 to 2006. About 80 senior scientists from across India endorsed unanimously that India undertake the human space mission.

There were three major areas that ISRO needed to master were, environmental control and life support system (ECLSS), crew escape system and flight suite. Under pre-project studies for which the Government sanctioned Rs 145 crore the distribution of funds was, Rs 61 crore for Crew Module System, Rs 27 crores for man rating of launch vehicle, Rs 36 crores for study contracts with national and international institutions, Rs 21 crores for other activities like aerodynamics characterization and mission studies.

In February 2008, NASA signed a framework agreement with ISRO that includes human space-flight co-operation.

At milestone “2009-2010” with an MOU with Russia, ISRO explored the plan to have an Indian on board on Russian spacecraft Soyuz in 2013 followed by Indian space mission in 2015. ROSKOS-MOS, Russian Space Agency on October 4, 2009, revealed the formal request to the agency, to fly two Indian astronauts in 'Soyuz TMA' ship to be piloted by a Russian cosmonaut.

The deal was to be commercial, but its value was not indicated, as it depends on the route and duration of the flight, which were yet to be finalized. Under this plan the Indian astronauts would not be taken to ISS. Russia reportedly charges about \$35 million for a space tourist's 10-day flight to International Space Station (ISS). It was also decided by ISRO that they would be redesigning the Soyuz space capsule of the Russian agency for Indian human space mission.

In 2010, it was also reported that ISRO has initiated discussions with Boeing company, in four specific areas of its human space flight project. A launch escape system (LES), an environmental control and life support system (ECLSS), a Vehicle Health Monitoring System (VHMSAT), reusable space systems and composite cryogenic tanks.

At milestone "2012" the Annual Report mentioned that in pre-project phase the funding is being used to develop new and critical technologies required for Human Space flight Program, which includes Crew Module (CM), Environmental Control & Life Support Systems (ECLSS), Flight Suit, Crew Escape System and Service Module Systems.

At milestone "2013" Crew Vehicle First Test Flight and Crew Module Re-entry Tests were planned. At milestone "2015" Schedule Revision was reported.

At milestone "2017" an ergonomic model of the crew module, that will take two Indian astronauts into space, arrived in Vikram Sarabhai Space Center (VSSC), Thiruvananthapuram, from Bangalore, where it was fabricated, at the end of April 2009.

At milestone 2018: We all meet. ISRO is to send first Indian into Space by 2022. The mission will be a turning point in India's space journey. ISRO reported that most engineering components are ready.

10. Right man at right time at right place for Human Space programme:

Dr Jitendra Singh MOS an endocrinologist of prominence.

2019 Future: Chandrayaan-2 and Gaganyaan

Dr Jitendra Singh is the right person, being a renowned doctor himself to play a pivotal role in this programme. This is going to be a big achievement, he said on 28th Aug 2018.

Addressing the press on the same day the ISRO Chairman, Dr Sivan said that ISRO has developed some critical technologies like re-entry mission capability, crew escape system, crew module configuration, thermal protection system, deceleration and floatation system, sub-systems of life support system etc. required for this programme. Some of these technologies have been demonstrated successfully through the Space Capsule Recovery Experiment (SRE-2007), Crew module Atmospheric Re-entry Experiment (CARE-2014) and Pad Abort Test (2018). These technologies will enable ISRO in accomplishing the programme objectives in a short span of 4 years.

GSLV Mk-III launch vehicle, which has the necessary payload capability for this mission, will be used to launch Gaganyaan, he said. Two unmanned Gaganyaan missions will be undertaken prior to sending humans. The total programme is expected to be completed before 2022, with first unmanned flight within 30 months. The mission will aim to send a three-member crew to space for a period of five to seven days. The spacecraft will be placed in a low earth orbit of 300-400km. The total programme cost is expected to be less than Rs. 10,000 crores.

Describing the mission as a complex one, ISRO Chairman said that it would truly be a national endeavour with the participation of ISRO, academia, industry as well as other government and private agencies as stakeholders. To accelerate the programme, ISRO may consider collaborations with space agencies, from friendly countries with advanced space programmes.

Giving details about the Gaganyaan, Dr Sivan said that it will comprise of a crew module and service module that constitute an orbital module. It weighs approximately 7 tonnes and will be carried by a rocket. The crew module's size will be 3.7 mts x 7 mts. The crew will do microgravity experiment during the mission. The crew will be selected by Indian Air Force (IAF) and ISRO jointly, after which they will undergo training for two-three years. While ISRO has perfected the engineering aspects of the mission, Dr Sivan said, bioscience is a new field for ISRO and requires collaboration and support from other organizations.

11. Starting point of Human Space Programme of India

Objectives of the mission

The Mission objectives are:

- Enhancement of science and technology levels in the country
- A national project involving several institutes, academia and industry
- Improvement of industrial growth
- Inspiring youth
- Development of technology for social benefits
- Improving international collaboration

The forthcoming projects of ISRO, including Chandrayaan-2, is scheduled to be launched in January 2019. The Mission will have an orbiter weighing 2379 kg, lander named Vikram weighing 1471 kg and a rover weighing 27 kg. Explaining the delay in launch of Chandrayaan-2, he said that the payload of the Mission has increased to provide for another component of the lander at 30 km orbit, which required a GSLV Mk III rocket for launch.

ISRO aims to launch 19 missions up to March 2019. These missions include launch of 4 satellites, to accomplish the Digital India programme by providing higher bandwidth for connectivity.

12. Solutions are found only if the problems are shared

Challenges that confront ISRO and IAM

Nil it seems. Everything has been covered by ISRO. Let us again wait and applaud from the galleries

or

We presume from the analysis of this paper, that gaps exist in what is being told to the press and what is available and be ready for that call, which always comes, but at the last minute.

13. The glorious past of India as its launch pad to go deep in “Space”

India and its stake in Space

I pay my tribute, today, to those men and women of my land, who, a few thousand years back had toiled beyond their capacities to invest in Indian intellectual portfolio, knowing well, that one day it will pay off. On the strength of their wisdom and on behalf of them, I stand here and am talking on a subject, which was as much a dream for them, then, as it is for us, today. I also know, that few years in future, someone will say the same, about all of us, the torchbearers in the subject of space and its medicine; that we took the decisions, that were right for the people of our land.

Over the years, India, fortunately has been a very cultured society. India has evolved, through the surplus, generated beyond food & shelter by hard working, intelligent people, who created this civilisation. In the process, it was exploited, as were other civilisations, by those who “did not have” through brute uncivilised force. The war machines were therefore required to keep this brute force away. It compelled the people, to keep part of their economic surplus, as a non-productive asset, to acquire, in the beginning an Army as land force and later Navy and Air Force to protect the land mass from sea & air. These brute forces are active throughout the world, even now and will remain so, in times to come. The budgets for maintaining the modern war machines thus contract & expand based on perceptions being created at economic conflict zones, resulting often in diplomatic stand-offs, which sometimes spill over to conflicts on ground.

Indian stakes in space, by the same logic must be protected, against the brute forces operating in this world. It is that new frontier, which requires investment today from India, to safeguard the future interest of 1.3 billion of its people, that represent one sixth of humanity. The first step to get that right is to put people into space. Not only to put men and women in space, but to develop the resources to put people in space, as a sustained continuous programme, at a pace decided by us. It is not to touch and scoot. It is to touch and stay. Those who deny us this investment today, by the arguments that we are too poor to afford a programme like this, that this is not the right time, that it is a dead loss to the country; will push us to the point, where in very near future, we will not be able to assert our opinions in the body of decision makers in the affairs of space. How can anyone think of denying its 1.3 billion people, the right to speak to protect its stakes in space. That right will come only by reaching there and claiming it. Space, in small ways has already started deciding the future of mankind. If we do not act today, we will deny ourselves to be a part of the panchayat of space, leave alone to be the Pradhan. We are late, but we are not at the fringes any more. Thanks to the knowledge bank and the physical ability to launch enough payload into space, that we can today, conceptualise a programme to put a human in space for India.

14. The Economics of Space Programme of India

Project Sanction and Budget

The Financial sanction is sought from the Department of Space, Government of India where in an amount of Rs 900 Cr may be sanctioned through ISRO to the Institute of Aerospace Medicine for the Gaganyaan Project under the provisions of Para 6.1.1 of Sanction of Expenditure as per the Book of Financial powers, which allows sanction of Expenditure up to Rs 900 Crores, if the Project is accepted by the Space Commission.

This fund may be made available by way of a Re appropriation from ISRO and can be made in stages based on achievement of defined milestones, which are partly enumerated in an old MOU (Memorandum of Understanding) between ISRO and IAM. A figure of about Rs 500 Cr may be considered prudent, since it comes within the Financial powers of the Space Commission, to allot for pursuing a project by way of Re-appropriation of funds from ISRO. The CCS route is not recommended since it entails a lot of Ministry like MOD, MOF etc., whereas going the Space Commission route, is a fast track route and can be influenced by the Minister of State for Space Commission.

Acknowledgement for Budget inputs by Gp Capt Frank George (Retd): domain expert in Financial Matters of National Projects:

15. Recommendations for Human space Programme of India

Roadmap Document MILESTONE-2018

This paper attempted to draw attention to the challenges that confront ISRO and IAM, together and suggest solutions to counter them.

Recommendations:

1. It is recommended to refocus the attention of the country on Operational Space Medicine for use in Indian Human in Space programme.
2. A new professional body “Indian National Aeronautics and Space Administration” (INASA) similar to say, European Space Agency (ESA) or Chinese National Space Agency (CNSA) or National Aeronautics and Space Administration (NASA) is recommended to be formed, as the civilian programme expands to include all national resources, for a long-term space programmes and not just a few flights.
3. Time has now come for IAM, to split its military and civil responsibilities. Land and resources must be provided by the stakeholders, to gradually form its civil wing as Human Engineering and Life Sciences Institute of Aerospace Medicine.
4. Similarly, Aircraft and Systems Testing Establishment (ASTE), IAF must create a civil wing covering Space Operations. It should also be the seed point of conceptualising the “Operational Squadron of Astronauts” in India.
5. Making of Crew Module should be the first target to be achieved.
6. The basic design be approved at the earliest, as all timelines and processes for selection, to training, to operations will emanate from what we decide to place inside the module.
7. As more information comes out in public domain, ISRO, it seems have not only frozen the design of three crew module but is ready to integrate the life critical technologies in the modules in a very short time. The final solutions reached by ISRO to cross the man rating milestones in last 4 years need to be shared with the stakeholders.
8. The Indian milestones of past works in aerospace medicine, specific to micro and macro environment, to help survive and sustain humans in space conditions, to select right people to endure in space and to train them to perform and survive in normal and abnormal situations are chronicled in this study and are recommended to be formalised. The quantum of work over past 40 years or so by IAM towards human in space domain, makes it most ready institute, as much as ISRO amongst many others, who are essential for the success of the programme.
9. ISRO and IAM are recommended to have joint roadmaps with specific roles and separate budget allocation to take India on the path to space and moon. These need to be defined urgently by the Space Commission of India.
10. IAM needs to support ISRO to work as one team, to help integrate the crew module with their stable launch platform to carry 4000 to 5000 kg payload, against approved human rating standards. This would also fast track the process to quick freeze the designs of crew module, ECLS, Space Suit for 3 crew missions of 4-7 days for 400 km orbital flight.

11. Formation of a good team at the earliest is essential. It needs to work 24x7 to meet the timelines. It is brought out in the paper that aerospace medicine. Flight Surgeons through IAM by default have a very vital role to play in the human space programme of India, in complete integration with ISRO, being the major driver.
12. Based on being prudent and cost effective, it is recommended to not expose three humans in first flight and reduce the risk to 1/3rd while increasing the resources to three times, for one crew.
13. Only after complete confidence is achieved in matching the CM with Launch Platform should we put more people in the CM.
14. Prepare for three, send one, in the first flight.
15. Prepare for more but initially go for one-man near-earth orbital mission for 24 hours, in the space capsule devised for three people.
16. This will also reduce the pressure on selection process of first set of astronauts to 3 while training 6, through modified known processes and is estimated to be completed within 12 months, from the pool of existing Test Pilots and other resources of India.
17. Basic and Mission specific training, that has already been worked out by IAM, would spread over a period of one and two years respectively, subject to freezing of Crew Module Systems. This would take D+ 3 years.
18. The period taken for freezing of Crew Module Systems is therefore recommended to be utilised by IAM, to start by Nov 2018, the selection process and on budget allocation initiate immediately the upgrading of existing basic training facilities, including centrifuge training of candidates.
19. The domain experts from IAM, must get involved at all stages of crew module integration, to be able to support it for multiple and regular space flights.
20. The rough estimate of the cost to kick-start the programme is Rs 11,500 crores spread over three years, plus 1725 crores per year.
21. For aerospace medicine, based on gap analysis of what we realistically have and what is essentially needed has been documented, to help make a budget estimate of Rs 1000 crores.
22. This investment will be required by IAM for aerospace support to utilise effectively the existing Human Centrifuge, High Altitude Simulators, Human Engineering Design Testing Labs, Environment Control Lab, Isolation study Lab, Anthropometric Lab, Night Vision Lab, Gas Chromatography Lab, Control Room Facilities with ISRO Links, Telemedicine links with major hospital resources etc, to match the parallel timeline that ISRO will require to complete the platform at Sriharikota.
23. The convergence of both IAM's and ISRO's programmes are recommended to happen by D+ 3 years i.e. 15 Aug 2021.
24. The paper anticipates an important role of IAF to help ISRO create the aerospace infrastructure resources, as civil extension of its Test Pilots School, IAM and Software Development Institute.
25. The paper also brings out the need to provide all the support to ISRO and IAM by the PMO, Space Commission of India, Indian Air Force and Armed Forces Medical Services for them to execute the short and long-term plans and be the fountainhead of aerospace medical and human engineering resources for this national programme.
26. The roadmap document recommends utilising all resources available across India, through citizen, institutional and industrial partnership, inclusive of Indians abroad to bridge the technological gaps.

27. It is reasoned that the time now is right for our nation to walk into space despite all the identified odds. Details of Industrial & Intellectual Resources collated as seed input has been attempted as part of this paper.
28. The Financial sanction is sought from the Department of Space, Government of India where in an amount of Rs 900 Cr may be sanctioned through ISRO to the Institute of Aerospace Medicine for the Gaganyaan Project under the provisions of Para 6.1.1 of Sanction of Expenditure as per the Book of Financial powers, which allows sanction of Expenditure up to Rs 900 Crores, if the Project is accepted by the Space Commission.
29. This fund may be made available by way of a Re appropriation from ISRO and can be made in stages based on achievement of defined milestones, which are partly enumerated in an old MOU (Memorandum of Understanding) between ISRO and IAM.
30. A figure of about Rs 500 Cr may be considered prudent, since it comes within the Financial powers of the Space Commission, to allot for pursuing a project by way of Re-appropriation of funds from ISRO.
31. The CCS route is not recommended since it entails a lot of Ministry like MOD, MOF etc., whereas going the Space Commission route, is a fast track route and can be influenced by the Minister of State for Space Commission.
32. The paper aims to help stakeholders to take decisions at the “Milestone 2018” on the roadmap to put Indians in space, as these decisions are expected to do much more for India, than merely help it to walk the path, where many have trodden.

16. Dangers of leapfrogging through purchase of technologies

Conclusion

ISRO has positioned itself at the space commission to prepare for two space flights with humans on board. While this obviously should be the first step, the conceptualisation should not stop here. The programme conceptualisation and planning will be worthy of the present minds, only if it prepares the roadmap for “what next”. The road map must cover the path to reach Space Station and then colonisation of moon. Presently, launch pads, ability to launch medium weight satellites and tracking abilities are in our hands. Based on this and the spectacular success of Chandrayaan, Mangalyaan projects, the desire to leapfrog into technologies that put humans in space is so strong, that it may retard the creation of our own ability to reach space. It has happened in the past, that is why this caution. Institutions remain, people who run them change. It should not happen, that after the success of two manned missions, the present generation, while standing in its glory make things difficult for the next generation, by achieving time driven objectives, through shortcuts required to leapfrog. With funds available and knowing well that we are not yet qualified to covert non-human rated systems to rated systems, it is obvious that we would take the path of purchase of technology to fill the gaps. Glamour of taking humans in space from our soil successfully is bound to create the perception that the goal has been achieved, while masking, as to how it was achieved. The present generation leaves the next generation with the burden, to reach the unfair goal posts of the past, through shortcuts, again. This takes us to the path where either we pay through ever increasing costs or we pay by failures. The technology and material gaps keep increasing exponentially. We have this responsibility towards our next generations which looks at us as pioneers, which we are not. They should not be left with the legacy of short cuts. We must leave enough budgets for the programme to continue making things on our own, as others have done from whom we buy our today. We must create our own materials, software, hardware and intellectual resources. With constrain of money we must set small goals which will help us reach the bigger goals. Someone should have a clear vision for this. Someone should be ready to be the Conductor of the orchestra. Someone must have the belief in the legacy and achievements of our past masters, a glimpse of it is still visible in the ruins of Humpty, in the Indian Calendar based on celestial movement, the metal pillar at Kutub, the architectural marvels sprinkled all across India. Someone also must believe in our coming generations and their super intelligence, working capacity, creative ability and the ability to take leadership roles in best of the industries and being best amongst equals. Someone must have faith in future India. I have. Rest I leave to your wisdom.

The recommendations in the form of “Aerospace Document: Milestone 2018” is now presented to the stakeholders.

17. The Last View

In India and unfortunately world over, the institutions tend to create their own selfish domains. To bring synergy, amongst the domain experts spread across the country, some known, some unknown is the biggest challenge for a national project. It is very easy to reach out to Russia and US, very tough to reach out to your own domain experts. In the bargain we have lost out 4 years and an opportunity to indigenise many facilities and processes. Why is it so difficult to take others along is a mystery? The narrow, myopic trait to keep everything for oneself, has crept from individuals to institutions at the expense of national interest. This, I think is happening to cover the internal gaps in knowledge in niche areas, which they are shy to accept in public. In the bargain perceptions are created which later cannot be matched with performance, when the crunch time comes. The small gaps of domain knowledge in niche fields, out of one's domain, I feel, should not be taken as their own incompetence, by the Institutions, least the gaps do not get filled, even though the resources are available with smaller, other groups. This unnecessary, institutional egos should better be avoided.

“National Security to me means, the ability to keep part of the economic surplus, created by hard working, intelligent people of India, as a non-productive expenditure, to provide them the freedom to invest beyond food and shelter, in the ever-continuing creation of our civilisation, without the fear of getting destroyed by the brute forces of those ‘who do not have’, the ability, to create on their own”

-Pankaj

Aerospace Document Milestone 2018
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