Engineers Conclave - 2022 October 13-15

Jointly organised by ISRO & INAE

Venue LPSC, Valiamala

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Inauguration of the Engineers Conclave-2022



The 9th edition of the three day Engineers Conclave jointly organised by Indian National Academy of Engineering and Indian Space Research Organisation was inaugurated on 13th October 2022 at Liquid Propulsion Systems Centre, Valiamala. The event was graced by the presence of Shri S. Somanath, Chairman ISRO, Prof. Indranil Manna, President INAE, Dr. V. Narayanan, Director LPSC and Lt Col. Shobhit Rai on the dais. The function was attended by esteemed engineers and stalwarts like Dr. S. Unnikrishnan Nair, Director VSSC/ISST Dr. Sam Dayala Dev D, Director IISU, Shri. Arun T. Ramchandani, Executive VP, Larsen & Toubro, and the former Presidents of INAE, Dr B.N Suresh, Dr. P.S Goel and Dr Sanak Mishra.

In the welcome address, Dr. V. Narayanan, Director LPSC and Chairman, Program Coordination Committee, elucidated the importance of the two themes selected for this year's conclave, namely, "Space for national development" proposed by ISRO and "Making India a global manufacturing hub" proposed by INAE. He opined that the plenary talks, lectures and deliberations will result in identifying national requirements and actionable recommendations towards implementation of the above two themes.

Prof. Indranil Manna, President INAE, Vice Chancellor, BIT (Mesra) Ranchi and a JC Bose Fellow, delivered the presidential address. He emphasized that INAE is a conglomeration of passionate and patriotic engineers committed to contribute to national development through engineering innovations. He presented an encouraging picture of the opportunities that lay ahead for Indian manufacturing sector in contributing to the global manufacturing arena.

Shri. Rajeev Chandrasekhar, Honourable Minister of State for Electronics and Information Technology and Skill development and Entrepreneurship, also the Chief Guest for the function delivered the inaugural message in video mode. He opined that there is a paradigm shift expected to happen in the next decade when India will switch roles from being a consumer of technologies to being an architect and designer in developing devices, products, platforms and solutions. He also emphasized the role of space in development of a country as innovations in space create cutting edge technologies for later use in non-space sector.

The event was formally inaugurated by the lighting of the traditional lamp by Shri S. Somanath, Prof Indranil Manna, Dr V Narayanan, Lt. Col Shobit Rai, Dr S Unnikrishnan Nair, Dr. Sam Dayala Dev D., Prof. Shivaji Chakravorti, Shri Arun T Ramchandani and Dr Prakash Chauhan. The book of abstracts was also released by the dignitaries. Shri S Somanath, Chairman ISRO, Secretary Department of Space and Chairperson EC-2022, delivered the keynote address on "Future Perspective of Space Ecosystem". He expressed that the space enterprise must be people centric and application driven. He opined that ISRO is currently in its expansion phase, looking forward to innovative missions, newer services, commercial solutions and global outreach. He laid out open challenges to the engineers to find ways to efficiently utilize satellite generated data in contributing more to economy. He also mentioned that INAE has a major role in identifying science objectives and building them up as national requirements to be pursued by ISRO and private players. He expressed hope that India will emerge a global competitor for launch vehicles and a market leader for satellite and application services in the near future. He identified challenges in innovation, manpower and infrastructure to be surmounted in this endeavour.

Lt. Col Shobhit Rai, Deputy Executive Director INAE and Member, Program Coordination Committee, delivered the vote of thanks acknowledging everyone involved in organizing, and those attending the conclave.

The inaugural function was anchored by Ms. Vishruti Gohel and Mr .Vivek S. Ms Madhavi rendered the invocation.

Following the inaugural function, an exhibition of engineering products, arranged at the venue was inaugurated by Dr. S Unnikrishnan Nair, Director VSSC/IIST and Dr. Sam Dayala Dev D, Director IISU.

Inaguration of Exhibition by Dr. Unnikrishnan Nair S, Director, VSSC/IIST and Dr. D. Sam Dayala Dev, Director IISU



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Press Meet at HRD Hall



52 journalists (including from 12 TV channels) were present for the EC-2022 Press meet. Shri S Somanath (Chairman, ISRO), Shri Indranil Manna (President, INAE) & Dr. V Narayanan (Director, LPSC) attended the press meet. The following is a gist of answers to quries from media personnel from print and video.

Chairman, ISRO elaborated on the 40 year-history of ISRO campus of Valiamala, from where the initial efforts in liquid propulsion were undertaken. A great deal of capability & capacity building has happened over the years, at various ISRO centres including LPSC Valiamala. ISRO worked initially on PSLV with traditional propulsion technologies. With expanding space horizons, ISRO has developed the exciting Cryogenic propulsion and currently is pursuing new & more efficient technologies like Semicryo and LOX-Methane for the launch vehicles.

Chairman told that ISRO has also begun the preliminary design of a New Generation Launch Vehicle, NGLV which will include evolving technologies in space sector and will replace our existing launch vehicles in due course of time. This new launch vehicle will have a payload capacity of 10T to GTO and up to 20T to LEO.

Chairman observed that ISRO has technological knowledge and skill to make the rockets and access the space. ISRO has been working on inclusion of new technologies, expansion of space sector and reduction of production time. With new private players and financial institutions in the space sectors, these knowledge and technologies can be translated to into a business model.

Chairman opined that, for building a business model in space sector, public-private partnership is required with the aim to expand the capacities, scale up the production, utilize the concept of reusability of the vehicles and reduce the cost of launch vehicle and improve the related services. ISRO has already started outsourcing PSLV to private industry. In a new digital India, demand for space technology has to be market driven and hence players with good understanding of market and financial institutions are to be part of this new race.

Shri Indranil Manna, President, INAE opined that in tune with the times, the educational sector also has opened up to cope up with the demands of the market. He reminded that in order to adhere to market demands, the problem solving skills would be given paramount importance. He also informed that manufacturing & technological bilateral programs with other countries also have been initiated.

The Press meet extended to almost one hour and was lively with interesting questions on the programmes and policies of ISRO and also on the Engineering and Manufacturing scenario of the country in general.

Plenary Talk 1 by Shri. Girish Wagh, Executive Director, Tata Motors

In the first plenary talk of EC 2022, ShriGirishWagh ,Executive Director –Tata Motors spoke about "Making manufacturing the next frontier for India's global leader ship-auto industry".

He talked about the history of the automotive industry of India and discussed about current and prospective manufacturing technologies in automotive industry. India is the fourth largest automotive manufacturer in the world and presently on the verge of attaining the third position. We have 40+ automotive OEMs and 800+ component manufacturers across India. Under the Automotive Mission Plan (AMP)-2026 of Government of India, Tata motors aims to propel Indian automotive industry to the engine (or heart) of the Make in India program by 2026. Automotive Mission Plan (AMP) 2026 envisages creating India as one of the top three automobile manufacturing centers in the world, targeting to export 35-40% of its total output. To realise this potential and leverage the encouraging policy measures, the auto industry continues to make constant efforts towards customer-driven innovation, focus on operational excellence and scalable platforms, embracing the future trends, collaboration, and brand building,



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with an ultimate aim to remain competitive and future-ready in the global landscape. Keeping in mind about the Industry 4.0, automotive industries are going for flexible manufacturing with sustainability.

Automotive industry is now shifting from traditional fuels to cleaner fuels like Hydrogen/ EV/ Fuel cell vehicles to reduce net

Parellel Sessions 1A and 1B

Carbon emission and for a sustainable future. He opined that manufacturing would need to undergo massive transformation as part of net zero Carbon journey. Tata motors has proposed to go zero carbon emission by 2045.



Dr. Sanak Mishra

Shri. K. Ramakrishnan

Shri. J. D. Patil

Post-lunch parallel sessions started at Nalanda Halls 1 & 2 in the Golden Jubilee Library Building.

The first session-IA was on 'Advance in Satellite communication' at Hall 1. Dr. P S Goel, former Director ISAC and former Secretary, Ministry of Earth Science, Govt. of India chaired the session and Ms.Athuladevi, DD, AVN, VSSC was the rapporteur. Dr. P S Goel opened the session on the remark that advances in technology are necessary for Indian Space programme to continue being relevant in view of LEO constellations taking over SatCoM globally.

Three papers were presented. Shri. Nilesh Desai, Director, SAC, ISRO presented the first paper on 'Emerging Technologies for Satellite Communication and Internet' where in global trends on very high throughput satellites, flexibility in communication payloads, mobile satellite services, high frequency and ubiquitous coverage, LEO & GEO constellations, NAVCOM – integrating navigation and communication services, Opto Quantum communication etc. were highlighted.

This was followed by Shri. Chandra Prakash, SAC, ISRO presenting on 'Emerging SatCoM Applications and Regulatory Challenges in Satellite Communications'. He touched upon emerging SatCOM applications including real-time aircraft and rail tracking system, maritime supply chain management, miniaturized mobile satellite service gadget, LEO/MEO satellite for direct to user mobile connectivity, DTH broadband and concluded by emphasizing on the need for multi layered hybrid communication network for disaster management. The final paper of the session was delivered by Shri. H. Rayappa, Director, SATCOM, ISRO on 'Regulatory Challenges in Satellite Communications'. A comparison of old (SatCOM policy 1997 & NGP 2000) Vs. Indian Space policy (2022) was brought out clearly further, policy provisions, procedures for acquiring orbit spectrum resources from UN body – ITU (International Telecommunication Union), important milestones to be met for acquiring spectrum rights were discussed.

The second session IB was on Enabling Eco-System for the domestic Manufacturing Industry. Session Chair was Dr Sanak Mishra and rapporteur was Shri. Alex A, DD, CSE/LPSC. The first talk was given by Dr. Tapan Sahoo, Executive Director (Engineering), Maruti Suzuki India Limited talked about future of mobility in India and policy enablers. He talked about the evolution of mobility over the last 120 years where the horses where replaced with horse power. Roads have become congested with automobiles presently. He explained about the five mega trends shaping the society and mobility which includes the climate change, ageing, rapid urbanization. Digital technologies and the rise of the middle class. Automobile manufacturing contributes 49% of the total manufacturing GDP in India. He talked about a slow evolution of mobility from internal combustion engines, to hybrid and electric vehicles supported by CNG driven vehicles. Due to the peculiar circumstances prevailing in India, we require a very unique solution for mobility- which are affordable and suits Indian traffic conditions.

Shri. JD Patil (FNAE), Member of Executive Council of Management L&T & Advisor (Defence& Smart Technologies) to CEO & MD L&T Limited & Former Whole Time Director, L&T Limited delivered a talk on Enabling ecosystem for domestic manufacturing industry with focus on infrastructure & policy enablers for technology intensive manufacturing. He informed the audience that about 1000 years ago, India use to manufacture 30% of manufacturing happening in the world which was reduced to 25% in the last 200 years. This drastically dropped to just 3%. With the right infrastructure and policy, India could regain its past glory. Indian manufacturing sector

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contributes to 16% of GDP in comparison to China, where it is 30%. One rupee invested in manufacturing sector has a multiplier effect as it is capable of creating Rs 7 down the line. From the pool of 1.5 million engineering graduates, only 20% of them have the right skills to be employed by the industry. Indian has a very strong start-up ecosystem with high risk appetite in the current generation of work force. Policy changes like lowering of corporate tax for the start-ups (from 30 to 15%) incentivized this growth. Defense Manufacturing and Space are the sunshine sectors in the Indian economy. Long term partnership with industries as done by ISRO is an ideal business model which had given rich dividends.

This was followed by talks on developing a demand driven High Quality Skilling Ecosystem for the Indian Manufacturing Industry by Shri K Ramakrishnan, Chief Executive -Skill Development Mission, L&T, Future of Mobility in India & Policy Enablers. He talked of the skill and re-skilling of the last man on the floor which will lead to improvement of quality enhancement automatically. He also talked about trainers training so that they can motivate their students to attain the required skills effectively. The trainers and workers should be given the big picture that their work contributes to the national building directly. He talked about a trainers training school run by L&T for the same.



View from the Audience



Dr. P. S.Goel & Mis. Athula Devi

On the sidelines of the conclave Conversations with Chairman, ISRO

What is your expectation from this edition of the Engineers' Conclave ?

If you look at this year's themes, Space for National Development and Making India a Global Manufacturing Hub, they may appear quite different. However, I would say that they are highly interconnected. Because of the national opening up of the space sector, India has the potential to become the space hub of the world. Manufacturing plays a very important role in this scenario. In the next few years, we should aim at supporting the demand for low cost small satellites for the whole world. In the light of this, this year's engineering conclave has a major role in enabling all these.

When we aim to become a space manufacturing hub, how self sufficient are we in raw materials?

We have a good pool of structural raw materials within the country itself and I would say that we are in a strong position even in special materials. In the electronics components sector, we do depend on global suppliers. This is a fair practice as the idea is not to indigenously manufacture 100 percent of the requirement. However, if we are denied something, we must and we shall manufacture it ourselves.

How about the availability of skilled and employable human resource in wake of the envisaged boom in manufacturing?

There is no dearth in the availability of skilled talent in our country. In fact, at the present level, we are not able to provide enough opportunities against the manpower that we have. The industry has to grow to provide the opportunities for the available skills. So with the expansion in manufacturing sector, we will be able to provide employment and also in the process generate still more skilled personnel.



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Parallel Session IIA & IIB

Theme 1: Space for National Development

IIA Remote sensing for agriculture and natural resource management: The session was chaired by Dr. Shailesh Nayak, Smt. Rajashree Bothale, DD, NRSC was the rapporteur.

The first talk on 'Natural Resources Management for National



Imperatives' was delivered by Shri. Shantanu Bhatawdekar, Scientific Secretary, ISRO Headquarters. He spoke in detail about the impact of the degradation in our natural resources, and the space- based technological interventions that can improve the situation. He also highlighted the different flagship programs of GoI to provide space-based information in the areas of optimal utilisation of vital resources, disaster management and impacts of climate change.

Dr. Bimal K. Bhattacharya of Space Applications Centre, ISRO delivered a lecture on 'Crop Forecasting and Precision Agriculture Using Space Technology'. He stressed on the importance of accurate estimate of crop statistics for importexport decisions, fixing MSP and to regulate price volatility of food commodities. He spoke on the GoI initiatives and national framework of FASAL, SUFALAM and IDEA (Digital Agriculture Initiative) as well as the four Rs (Right Application rate, Right Source, Right time and Right location) which form the basis of Precision Agriculture.

Shri Prateep Basu, CEO and Co-founder of SatSure, a company which specializes on providing Crop Insurance to farmers spoke on the topic of "Aiding Crop Insurance through Geospatial Technologies'. He spoke about the complexities of data collection which may discourage the potential users from easy access. He told about how crop insurance is being transformed using satellite imagery, Machine Learning and Statistics using SatSure's Decision Intelligence Model.

Dr. Mehul R. Pandya of Space Applications Centre, ISRO delivered a talk on 'Space Technology for Environmental Disasters – Air Quality & Forest Fires'. The impact of air pollution in India can be deciphered from the statistics that 21 cities in India figure in the list of 30 most polluted cities of the world. In order to monitor air pollution, satellite based imagery is key to providing synoptic and systematic views. The new generation EO satellites with increasingly high spatial and temporal resolution are able to detect atmospheric pollution levels and can be utilized for better forest fire monitoring and management.

Theme 2: Transforming India A Global Manufacturing Hub

IIB Adopting and learning from global practices in the manufacturing sector: The session was chaired by Shri. T Suvarna Raju, HAL and the raporteur was Shri. A. Narayanan DD, IPRC.

Prof. R.R Sonde, Professor at IIT Delhi and former Outstanding



Scientist BARC delivered the talk on the five key disruptive drivers in metallurgical and material

processing in Heavy industry sector. Cost competitive manufacturing enabled by critical design thinking is one of the driving factors. Adoption of new raw materials and additive manufacturing, the use of AI/ML tools for design analysis, concepts of circular economy wherein waste minimisation receives attention leading to sustainable value chain and the need for switching to renewable and green energy were underlined as the other driving factors.

Shri V Ravichander, Global Co-Chief operating officer, Dynamatic Technologies limited delivered a talk on how an Indian company in the manufacturing sector had grown into a global brand by resilient efforts and was constantly innovating and adapting to the demands. They had successfully developed and practiced a global best value model by leveraging complementary advantage between UK and India. In his opinion, customers look forward to India manily due to the 3D engineering skills, ability to re-engineer and reverse engineer from products resulting in novel solutions.

Plenary Talk 2: Blue Economy Development



The second talk plenary of Engineers Conclave - 2022 delivered was by Dr. Shailesh Nayak, Director, National Institute of Advanced Studies (NIAS), Bangalore and Former Secretary, Ministry of Earth Sciences on the topic 'Blue Economy Development'.

Dr. Nayak explained on the significance of satellite data in not only enhancing fish harvesting but also in the study of the impact of climate change on the regime shift in fish population.

He also stressed upon the enormous potential in developing renewable energy from the Marine ecosystem in the form of offshore wind energy, wave energy, ocean currents, thermal energy and biofuel from Marine algae. The speaker enumerated on the R&D initiatives taken in the arena of ocean development. The speaker also specifically mentioned the ongoing development of the vessel Matsya 6000 in collaboration with ISRO, the vessel being aimed to be deployed in 2024.

He concluded his talk by throwing light on the way ahead and enumerated the efforts taken by the Government of India in this direction through 'Deep Ocean Mission' and to provide an institutional framework to the 'Blue Economy' useful for societal relevance and to facilitate sustainable growth.

Plenary Talk 3: Space for Earth Science

j India a global manutacturing



How space borne platforms population live near the oceans and 70% of the mega citiesare observe and also near oceans. This makes the study of oceans systems very help us understand climate systems critical for all the social and economic activities happening plenary talk Information

the importance of oceans which cover 70% of the earth's area predicting the effects of climate change. and generates 50% of the air we breathe. Half of the world's

and oceans? This was the on the land. INCOIS primarily focuses on the ocean end to main theme of the third end value chain- starting from the collection of data from delivered various instruments to understand, model and predict the by Dr. Srinivas Kumar ocean behavior. He stressed on the use of satellite data to Tummala, Director Indian be converted into useful services such as identification of National Centre for Ocean potential fishing zones, cyclone or tsunami warnings, oil spill Services tracking, marine heat waves, coral bleaching and sea swells (INCOIS) on the topic which can directly benefit the society. He concluded by Space for Earth Science. stating about the development of a digital ocean map along Dr. Srinivas dwelled on with coupled earth system models which are significant for

Plenary Talk 4: Emerging Scientific Missions



the fourth plenary In talk of EC 2022, Dr Anil Director, Bharadwaj, Physical Research Laboratory (PRL)spoke about "Emerging Scientific Missions in India".

Dr Anil Bharadwaj mentioned about the humble beginning of space activities in India with first rocket launched in 1963 & first Indian satellite

Aryabhatta in 1975. From such modesty, India has grown up to undertake complex & cutting edge scientific missions like

Chandrayaan-1 & 2, Mars Orbiter Mission (MOM) etc.

Chandrayaan-1 launched in 2008, found that traces of water on moon. The mission provided surface mapping of the moon. It gave India's first ever picture of the earth, from the moon. Mars Orbiter Mission (MOM) completed 8 years in November 2021. MOM carried 5 experimental payloads to study surface features & atmosphere of Mars. MOM gave beautiful pictures of Deimos & Phobos, two moons of Mars. Chandrayaan-2 was a lander & orbiter mission. Payloads available in Chandrayaan-2 studied Moon's surface with very high resolution images.

Dr Anil Bharadwaj concluded his talk by shedding light on India's future missions like Aditya L-1 to study sun, Chandrayaan-3 to study moon, MOM2 mission to Mars, mission to Venus etc.

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Parallel Session IIIA & IIIB

Theme 1: Space for National Development

IIIA Space for National Security:

The session was chaired by Dr. B. N. Suresh. Dr. M. S. Suresh,



AD, LPSC was the rapporteur.

The first talk on 'Space, the Fourth Dimension of National Security' was delivered by Dr. P. S. Goel,

Former Secretary, Ministry of Earth

Sciences. He stressed on the importance of Space as an enabler for national security with its unrestricted communication and imaging capabilities. He opined that NAVIC capability is on par with that of GPS; and that the supporting operations of missile defense, jamming and spoofing, support beyond boundaries can be provided by ISRO. He cited the example of how the US invaded Iraq by downing all communication networks overnight, to stress the importance of Space in warfare.

Dr. P. V. Radha Devi, Director, ADRIN spoke on 'Observational Platforms for Geo Intelligence'. She traced the transition of platforms from Photo Intelligence (PHOTOINT) through Imagery Intelligence (IMINT) to the presently used Geospatial Intelligence (GEOINT). GEOINT consisting of imagery, imagery intelligence and geospatial information have been strengthened by AI/ML and DL tools for converting data information to knowledge information.

Air Marshal Saju Balakrishnan AVSM VM, HQ Training Command delivered his talk on 'Space Based Systems for National Security'. He stressed on the importance of monitoring using space based systems, as the mountainous terrain at the borders limits other methods of surveillance. Actionable intelligence as required by the Armed Forces can be provided by Space based solutions in the fields of precision navigation, communication and near-real-time surveillance. He pointed out the necessity of enhanced civilian-military cooperation, enhanced industry participation and assimilation of IRNSS into military systems.

RAdm K. M. Ramakrishnan, VSM, ACNS (CSNCO) spoke on 'Space for Maritime Security'. Maritime security is a challenge since the Indian Ocean Region caters to 25% of world population, 66% of oil trade and 50% of container shipments. He stressed on the directiveby the GoI to stress on the three pillars of Space, Maritime and NorthEast Region to make India a developed nation by 2047. He spoke on the threats to maritime security, and the key challenges facing the sector. To cater to improved oceanic surveillance, maritime-specific payloads need to be developed. He opined that opening of space sector could go a long way in meeting the maritime security requirements.

Theme 2: Transforming India A Gllobal Manufacturing Hub

IIIB Quest, Chalenges& Way forward-Sector specific initaitives for making india a global hub for mass manufacturing industries



The session was chaired by Dr. Shivaji Chakravorti. Shri. G. Nageswaran, DD, LPSC was the rapporteur. In his talk on Technology Innovation in Agricultural Equipment, the speaker Dr. Satyam Suraj Sahay, Head of Advanced Engineering, John Deere Technology Centre, India , opined that Connectivity, Autonomy, Artificial Intelligence and Machine learning , Big Data and electrification are the technology advancements that agricultural sector should implement. Connected Machines lead to reduced input cost, increased yield and diagnostics. He also presented use cases related to computer vision for target weed spraying and wear mechanism modeling to reduce wear and improve life of machinery by 6 fold. He said that recyclability of products would be the future.

Shri. V. V. Risbud, Vice President & Head – Manufacturing Technology and & Digitization, Larsen & Toubro Heavy Engineering expressed his views on "Heavy Industry: Quest, Challenges and the Way Forward". He presented the challenges faced by capital goods manufacturing like high investment and long gestation period, high energy cost, poor infrastructure and poor connectivity which limit heavy engineering sector to a slow growth rate of 3%. He suggested investment in Internet of Things (IoT), usage of growing startups for smart manpower, skill building and infrastructure development as top priorities during policy making to harness the large Indian workforce and consumer base.

Shri Anupam Rawat, Vice President – Operations, St Gobain delivered an informative talk on "Specialty Chemicals". He expressed his perspectives on the chemical processing industry citing the technological gap that India has bridged in the past 20 years, but huge monetary investment involved in this sector still prevent new technological development. He explained how labour codes, legislation and unionization prevent the growth of labour intensive industries in India resulting in countries like Bangladesh capturing the international market of textiles. He recommended setting up of Hybrid power plants using bio-fuel and solar energy alongside coal as a way to meet huge energy demands of industry and achieving the sustainability development goals by minimizing the carbon footprint.

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Cultural Programme

After intense deliberations throughout the day-1 on finding more avenues of



using space for National development and transforming India into a global manufacturing hub,

a cultural programme was organized in the evening on the first day of Engineers Conclave 2022, i.e. on Oct. 13, 2022 to soothe the nerves of the delegates and guests and to introduce them with the rich traditions and culture of Kerala, the 'God's Own Country'. The first event of the programme was a bunch of dance performances by Natraj Dance Academy,

S. G. Sanal Kumar And Kalakshetra Smt. Jisha Raghay. The programme started with a Mohiniyattam

S. G. Sahar Kumar And Kalakshefra Sint. Jisha Kagnay. The programme started with a Mohimyattam performance which was an invocation dedicated to Lord Ganesha. It was followed by a Kathakali dance comprising of the Kalashams, the rhythmic movements and the gestures in praise of Mahishasura Mardini, incarnated to kill the demon king Mahishasura. The next piece was a Tamil folk dance depicting the quarrel between Lord Ganesha and Lord Subrahmanya for a fruit given to Lord Shiva and Goddess Parvati by the saint Narada. It is believed that when Ganesha emerged victorious, Muruga embraced austerity and became Palani Andavan. It was followed by a keertanam by Swati Tirunal, the erstwhile Maharaja of Travancore, in praise of Lord Padmanabha who is reclining on Ananta, the king of snakes. The dance event concluded with the Thilana, which was set in a jugalbandi format of Bharathanatyam, Kuchipudi and Mohiniyattam.

The second event was a series of breathtaking performances of Kalaripayattu, the oldest form of martial arts of Kerala, which is believed to enhance focus, strength, resilience, fearlessness and discipline among its practitioners. The performaces were by Agasthyam Kalari under the guidance by Dr. Arun Surendran. Comprised of nine events namely Guru Vanakkam (Guru Vandana), Chuvadu (step), Kaiporu (free hand), Kathi (knife), Meyypayattu, swords, swords and shield, Neduvadi and Urumi, the Kalari performance displayed the barehand techniques as well as weapon based techniques. As a token of appreciation, mementoes were presented to Shri G Sunilkumar and Dr. Arun Surendran by Shri. S . Somanath, Secretary, DoS/Chairman, ISRO on behalf of the organizing committee, EC-2022. The last event was a live performance by Rock@ band, a group of musically talented employees of ISRO. The performances started by a rendition of group song AyagiriNandini depicting the power of Goddess Durga. It was followed by rendition of popular solo and duet songs as well as Instrumental fusion and medley on flute and saxophone.

The performances had mesmerizing effect on the audience who were spellbound by the quality and variety of the events showcased. The cultural programme was followed by a gala dinner for the delegates and guets and their family members.

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Parallel Session IIB

Theme 2: Transforming India A Global Manufacturing Hub

IIB Adopting and learning from global practices in the manufacturing sector:

Dr Jitendra J Jadhav, Director, Aeronautical Development Agency (ADA-DRDO) delivered an informative talk on the topic, "The Indian Aviation Industry – set to take off". He elaborated on the challenges facing the aircraft manufacturing industry and stressed on the need of the hour to rely on a multi-tier manufacturing approach indulging in



advanced manufacturing technologies like Hybrid machining, Cryogenic machining, closed die forging, jig-less optical aided drilling/riveting, precision manufacturing etc. He emphasized on supply chain management tools and enhancing the skill sets of manpower to deliver a better quality product with less turnaround time.

Shri S ManickaVasagam, General Manager, Aircraft Division, HAL, delivered a talk on Globalisation of Aerospace &Defence Manufacturing. He highlighted the uniqueness of defence manufacturing, best technologies currently being used in HAL and practices for the future. He envisaged the vision of global manufacturing in defence aviation sector in which HAL and other major players would play the role of integrators and designers to tier-1 and tier-2 private industries, building a comprehensive system to achieve the goal of 25 bn USD turnover for Indian defence industry by 2025.

Parallel Session IVA &IVB

Theme 1: Space for National Development

IVA Space for economy / commerce : Opportunities The post lunch parallel sessions continued at Nalanda Halls 1 and 2 in Golden Jubilee Library Building.



The first session IV A on 'Space for Economy/Commerce: Opportunities' was conducted in Hall 1. Shri. Nilesh Desai, Director, SAC, ISRO chaired the session and Shri. Ashok V, Deputy Director (Aeronautics Entity), VSSC was the rapporteur.

Four papers were presented. Shri. Rajeev Jyothi, Director, IN-SPACe presented the first paper on 'Self reliance in Space Enterprise- overcoming hurdles through industry, academia, institutions collaborations and policy framework'. He clearly laid out the significance in the step of outsourcing ISRO's facilities to emerging Non Governmental Enterprises (NGE) in Space Industry towards fostering space ecosystem in India. This is essential to capture much more than the current 2% share in the global space market, he added. Trends in space business and innovative technology, global and indian space ecosystem, space incubation system, current scenario and Indian Space Policy, role of INSPACe etc. were some of the key points of the presentation. He stated that presently about 100 applications seeking services from ISRO, from various NGEs are under evaluation. He deduced that keen interest from various NGEs, MOUs with potential start ups and academic collabartions are strides towards unlocking India's potential in space sector. Space reforms 2022 are on the anvil.

This was followed by a talk by Shri. A Arunachalam, Director (Technical Strategy), New Space India Limited (NSIL) on 'Indian Space Economy - The Vision and Focus Areas'. He illustrated the space value chain with downstream and upstream segments. The current status of global space industry specifically with respect to satellite services, manufacturing, launch and ground equipment industry and prediction of satellite industry trends for 2020-2029 were some interesting topics presented with supporting statistical data. The global space economy will soar from the current USD 370BN to USD 642BN in 2030 as per Indian economy survey report. The Indian space economy is heralding a new era with space reforms for a larger share in the global market facilitated by the coming up of NSIL and IN-SPACe, he concluded.

The third paper was presented by Smt. Anamika Das, Vice President, Geospatial World on 'Geospacial Market Trends and Directions'. She dwelled on how the geospatial market is emerging to be the hot spot of technology market place. The global geospatial market is forecasted to be USD

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681BN in 2025, wherein GNSS and positioning captures 45 percent of the total market share. Hence, the geospatial and drone (amendments) rules 2022 garners significance. The possibilities of leveraging technology to become a global GNSS hub were discussed. Glimpses of specific notables in GNSS market that are transforming, geospatial industry value chain and role of data infrastructure in digital twinning were provided. Geospatial data is the backbone of Industry 4.0, bigdata and internet of things, she stressed. In addition to GPS, sub-surface analysis and mapping are coming up in a big way as potential future avenues, she said wrapping up.

The final paper of the session by Shri. K S Parikh, Associate Director(R&D), SAC, ISRO on the behalf of Dr Manish Saxena, Director, Satellite Navigation Programming Office was on 'NaviC and Emerging Applications'. He started by elaborating on the structuring of the regional NaviC system in terms of its space segment, ground and user segment, key features, upcoming configurations and technical advances. He also shed light on the various applications of GNSS as in vehicle location, warning, drones, timing synchronisation and the possibilities ahead, promising new technologies like autonomous connected vehicles, precision farming, integrated property validation etc. This along with the integration of 4 G and 5 G will be a potential contribution of the NaviC. As concluding part, the future and emerging concepts in satellite constellation like LEO constellations, inter satellite communications, PNT constellation, Lunar PNT etc. catering to further extending the Space service volume were highlighted. The indigenous development of atomic clock by SAC/ISRO planned to be inducted in upcoming missions, was well appreciated by panelists and delegates.

Theme 2: Transforming India in to a Global Manufacturing Hub

IVB Quest, Challenges and the way forward-Sector specific initiatives to make India a global manufacturing hub in high technology manufacturing:

The session on 'Quest, Challenges and the way forward-Sector specific initiatives to make India a global manufacturing hub in high technology manufacturing' was chaired by Shri. V.V.R Shastri with Shri.Padmakumar, AD, VSSC as the rapporteur. There were four speakers who touched upon all aspects of the theme. The session chair remarked that the topic is very exciting and is highly relevant for today's world.

The first talk was delivered by Dr. Aloknath De, Senior Vice-President and Chief Technology Officer Samsung India Software Operations Pvt. Ltd. Along with Dr. M.J.Zarabi, former chairman-cum-managing director of Semiconductors Complex Limited. Dr. De informed the audience that semiconductor manufacturing in India was active from the 1950s through companies like Bharat Electronics Limited and Semiconductors Limited, Pune. The Semi-conductor Complex



Limited (SCL) was initiated by the government in 1976 and finally became operational in 1981 at Mohali. Starting from a 4 inch wafer size with 5000 nanometer (nm) CMOS components, SCL has progressed now to 8 inch wafer with 180 nm size with the help of Tower Semiconductors. Though world is now into less than 7 nm transistor size, SCL is the only fab facility currently available in India. Semi-conductor fabrication is in the early stages in our country. The top fab companies are TSMC and Samsung and Government of India has to create policies and frame work to tie up with them to create a fabrication facility within the country. A joint venture between Vedanta and Foxconn is also in the offing. Government recently promised an investment of USD 10BN towards India Semi-conductor Mission.

Shri.Bhaskar Bhatt, former chairman of Titan, delivered the next talk on Consumer Electronics. He urged the participants to see ideas like the standardization of design and mass manufacturing with a different perspective. He talked about the need to focus on green manufacturing, recyclability & sustainability and focus on reducing e-wastage. He presented the global market trends on artificial intelligence, Internet of Things, domestic robotics and full home automation.He discussed about focusing technology for rural areas and for the educational sector.

The next talk on 'Telecommunication in the 5G Era' was given by Shri. Rahul Vatts Chief Regulatory Officer Bharti Airtel and Director, OneWeb India. He opined that technology has democratized access to information, opportunities and increased efficiency. The shift to 5G will increase the data rate 10 times. The current data rate of 1Gbps with 4G will increase upto 10Gpbs with 5G. It has very low latency and is well suited for applications like full factory automation including robotics. HD voice and video calls and various applications based on augmented and virtual realities can be easily supported with 5G technology. On the other hand, OneWeb provides satellite based solution to provide internet connectivity to the remotest location on earth. He put forward policy decisions which if taken in consensus with the Government of India, will help provide the telecommunication services to be more effective to the common public.

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The last talk on 'The future of Manufacturing' was given by Shri. Jawahar K from the TCS. He explained about the neural manufacturing technologies proposed by TCS to take the manufacturing area to reach its full potential. This is TCSs answer to industry 4.0 where a Cognitive Plant Operations Advisor- which is a combination of artificial intelligence (AI) building on adapting and learning enterprise will manage the factory. It combines knowledge, data and science and produces comprehensible actions to people on the floor like the plant manager or operator. Things like asset performance management where a set of machines can be efficiently operated with minimum downtime, is a typical application.

Parallel Session VA & VB

Theme 1: Space for National Development

VA Space for disaster forecast / mitigation : The session was chaired by by Shri. Shantanu Bhatawdekar, and Shri. Harish CS, DD, MSA, VSSC was the rapporteur.



The first talk on "Space based Inputs for Disaster Risk Management and Risk Reduction" was delivered by Dr. Prakash Chauhan, Director, NRSC, ISRO. He spoke about the natural disasters like floods, landslides, cyclones, forest fires, earthquakes, drought etc. and possible disaster management solutions & risk assessment for different scenarios. He stressed on ISRO's role in Disaster Management Support (DMS) program that addresses various aspects of natural disasters in the country using satellites & space based inputs. ISRO also provides real time information support to Ministries/ Departments prior, during and after natural disasters for timely and quick management decisions. He ended his talk with major projects undertaken for natural disaster management like warning systems for Mountain hazards, Landslides, Glacial Lake outburst floods (GLOFs) and cloud bursts etc. Dr. Krishnan Raghayan Director UTM/MOES delivered

Dr. Krishnan Raghavan, Director, IITM/MOES delivered talk on "Climate Change and Disasters". He spoke of humaninduced climate changes that has warmed up and still warming the atmosphere, oceans and land. Humans single-handedly have altered the earth's eco-system in multiple ways. Effects of industrialization & modernization are already evident and it is affecting even the remotest places on the earth in the form of extreme weather & climate conditions.He talked about consequences of climate change on weather extremes, monsoon rainfall and associated disasters over Indian subcontinent.

Dr. S P Agarwal, Director, NESAC, ISRO delivered talk on "Space Technology for Disaster Risk Management in North East Region". He spoke about natural disasters like Floods, Landslides, Cyclones, Thunderstorms & River bank erosions etc. that hit frequently in different parts of North East India. He informed that North Eastern Regional node for Disaster Risk Reduction (NER-DRR) is established to provide single window delivery of the space based support for Disaster Risk Management in NER. He talked about achievement of NESAC in predicting several cyclones, developing flood warning system in NER and providing early alerts for natural disasters. Fourth talk on "Space Technology for Environmental Disasters - Air Quality & Forest Fires" was delivered by Dr. Mehul R Pandya, SAC, ISRO. He spoke about poor & degrading Air quality in different parts of India & its effects on our lives. He informed that forest fires further degrade the air quality and inject poisonous gases in the atmosphere. In order to monitor air pollution & forest fires, satellite based instruments are key for providing synoptic & systematic view for observing wide range of chemical species in the atmosphere with increasingly high spatial & temporal resolution.

Theme 2: Transforming India A Global Manufacturing Hub

VB Industry 4.0 & Manufacturing R & D : The session was chaired by by Shri. Arun T. Ramchandani and the raporteur was Shri.Padmakumar, AD, VSSC



Mr. C. K. Shibin, Head of Portfolio Development for Aerospace and Defense at Siemens India spoke on 'Artificial Intelligence and Machine Learning technologies in Manufacturing'. He spoke about the Digitalisation of Manufacturing where 'Data' is the master in Industry 4.0. He elaborated on the five aspects of manufacturing in the Smart Factory, where AI/ ML

improves on the process.

Prof Indranil Manna, VC BITS Mesra and President INAE delivered his talk on 'Perspectives and Prospects of Laser Assisted Additive Manufacturing'. He spoke about the advantages of laser assisted manufacturing against the conventional manufacturing methods, and explained in detail about the process of LAM. Research carried out in the field was also touched upon.

Dr. Rohini Srivathsa, National Technology Officer, Microsoft India spoke on 'Manufacturing for a more Resilient and Sustainable Future'. She spoke of the disruptions caused to the manufacturing industry in the wake of the pandemic, and stressed the importance of making our factories more agile and our supply chains more resilient considering the fact that India is poised to become a global manufacturing hub. She also spoke on the potentials in the industry to unlock innovation, deliver new and sustainable products and services.

Plenary Talk 5: India as an emerging world power-Challenges and opportunities



The fifth plenary talk of Engineers Conclave 2022 was delivered by Shri G Mohan Kumar, IAS (Retd.), former Defence Secretary, Government of India, on the topic 'India as an Emerging World Power - Challenges and Opportunities'. In his talk, he gave a macro view of the current state of economical health, defence preparedness and technological development of India vis-à-vis the world scenario and shared his thoughts on the growing challenges to India.

Shri Mohan Kumar highlighted the changing geo-political situations and the world order wherein the increase in authoritarianism in China, widening inequality and emergence of far right regimes in Europe and USA, increasing

trend of protectionism and a nuclear one-upmanship and increasing obsolescence of United Nations are leading the world to strange geo-political situations and are changing its multipolarity to sort of Sino-US cold war situation. With this backdrop, he strongly felt that India need to be militarily and economically powerful if it wants to be powerful and become a developed state by 2047, as envisaged by the Hon'ble Prime Minister in his Independence Day speech. He felt that to do so, India need to grow at least by 9% annually which could only be achieved by growth in manufacturing and technological development with the policies of inclusive growth, sustainability, energy security, universal availability of health and education as well as skill development being the key drivers of this growth. He lamented the lack of strategic approach in defence manufacturing and lack of strategic autonomy in decision-making in the past decades and cited heavy dependence on imports of military equipments, lack of defence manufacturing ecosystem, lack of private participation and wide gap in technological capabilities as the major impediments in India.

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Giving examples of technological leapfrogging by China in the fields of electronic warfare, cyber warfare, missiles, communications, stealth aircrafts, submarine etc. as well as its technological advancement in the frontier areas of quantum technology, the speaker drew attention of the audience to widening economic and military gap between India and China and stressed upon the need for urgent technological innovations and enhancement in manufacturing capabilities in India if we want to become world leader. He specifically cited the dominance of China in controlling the supply of rare earth metals to the rest of the world and juxtaposed it with state of affairs in India where due to lack of strategic thinking we could not ulitilise this probable leverage despite having large resources of such materials at our seashores.

He hailed the initiatives by Govt. of India recently such as Atmanirbhar Bharat policy, separate budgetary allocation for domestic products and earmarking 25% of defence production budget for private sector as the pathbreaking steps in the right direction and expressed hope that these policies would incubate innovation in technology, attract private investment in manufacturing, especially in defence manufacturing, and spur economic growth, thus leading the Nation to attain selfreliance and technological leadership in the world.

He exhorted the engineering community to find urgent ways to reform the higher education set-up, especially the engineering education and devise strategy to reverse the brain drain from India. He suggested to overhaul the curriculum with focus on skill development and to develop the mathematical skills of students in order to attain leadership in newer fields such as Artificial Intelligence and Machine Learning. He also expressed need to promote resource talents in a big way and have National missions in all critical and frontier areas. He further emphasized on the need to have complete control in technology if India wants to become leader and have sustained leadership in the world order.

Plenary Talk 6: Challenges in human space mission



Dr. S Unnikrishnan Nair, founder director of Human Spaceflight Centre, HSFC, Bengaluru and currently Director, VSSC, Thiruvananthapuram gave an excellent overview on the Challenges of Human spaceflight as the sixth and final plenary talk. He initiated the talk giving a glimpse of the history and evolution of the human spaceflight starting with the pioneering contributions of the erstwhile USSR and the USA. Calculated risks were taken and outstanding feats were achieved in the 1960s, including humans landing on the moon. The seventies were the era of space station, in which the Soviet Union launched a series of Salyut space stations and the US chipped in with Skylab. The new millennium saw the entry of China also into the exclusive human spaceflight club. Another major game changer has been the entry of private commercial space players, especially in the era of space tourism.

In his talk, he highlighted the various challenges associated with human spaceflight; including the hostile environment, rigours of the ascent flight, adapting to space environment and the arduous re-entry. He also elaborated how each everyone of the above are addressed by various engineering aspects, such as building reliable launch systems, provision of crew escape system, crew training and establishment of facilities. The specific aspects of India's own human spaceflight endeavours viz. Gaganyaan were explained, including various advantages it brings to our scientific community and the nation.

He concluded by delineating the possible future course of human spaceflight missions, including interplanetary missions and space colonies and how such missions bring the humanity closer through international collaborations.

In conversation with Dr. Shivaji Chakravorty

Vice President, INAE



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Sir, what do you think is the way forward for making the country a manufacturing hub? What are the challenges? What are your expectations about the coming years?

India has 20% of the design engineers of the world. We have to move from design to products by initiatives like Make In India. We have to move in to an ecosystem of three tiers of manufacturing acting like a pyramid, with the lower players making the components and the bigger players assembling the components and making the products and systems. The concept called factory on wheels is the basis of all these things. Sir, How this conclave is different from the previous conclaves? How has been the audience?

I understand there was meticulous overall planning and I compliment the entire team. Even at 6 pm, I see that a huge number of delegates are actively attending and interacting. I have never seen such an active audience in conferences like this. I think that all these are equally because of the ISRO ecosystem and the type of topics arranged for the conclave.

Sir, how can we bridge the gap between engineer's curriculum and their job profile?

This is a complicated question. Apart from the curriculum, we need to develop a right attitude towards the profession. We need to tell youngsters to improve upon their power of observation, if they have to be successful in life.

Sir, do colleges need to emulate the IITs curriculum and way of teaching?

India is a heterogeneous country. We need to think a lot on giving hands on experience to students, with tie up with industries. We need to make them aware about the harsh realities in the professional life, to make them fit in to the real life. Sir,What is the future of INAE and Engineers Conclave?

The role of INAE is to guide the policy makers. Policy makers need inputs from many areas. INAE prepares broad-based guidelines for them with a futuristic view. We hope that our recommendations play a greater role in the policies of tomorrow.

In conversation with Dr. Indranil manna

President, INAE



In the press meet you mentioned about problem solving skills required in engineers. Can you elaborate?

Engineering is all about providing real solutions to address the aspiration and challenges faced by society. For example there is no replacement for laws of thermodynamics, laws of physics. So you have to begin there and at the same time, do an entire exercise to a level where a student is trained to approach, define and make an effort to solve the problem.

What is the general situation in country for engineering? In our times, we were required to do project in final year of graduation. It still exists in the curriculum. But how many students go to industry for project before graduation? How many students do hands-on projects? Many a times it becomes term paper, review paper or literature paper. We want student to test the failure at that stage so that they could be successful tomorrow, so for that reason problem solving skill for engineering students in their curriculum is very important. Internship to the industry should be mandatory. Today even in many IITs you will find large number of graduates who have not seen an industry or done any project. So when you are in a classroom, you don't see the scale of operation in an industry. But if you are producing 1.5 million engineers a year, country doesn't have the capacity. So that's why, there has to be a review and re-look on this situation.

How do INAE make suggestion to political establishment?

Engineer conclave was designed for making suggestions for the benefit of the country. The topics chosen are very relevant and interesting. We chose 2 themes for EC-2022- space for national development & Transforming India into a Global manufacturing hub, which we feel, will go a long way in to the decisions made by the political establishment.

Give us your overall feel about EC-2022?

This is very rare occasion where we find people in packed halls even on the last date of conclave. This is an event where we were able to find eminent personalities and speakers from different industries and areas. This is why EC-2022 is very successful.

We are extremely grateful to ISRO for gracefully hosting the event at LPSC.

In conversation with Dr. V. Narayanan

Director, LPSC

Sir, Being Director of Propulsion Centre, what are the new propulsion systems that will power future space systems? Well, Coming to propulsion systems in space, both Launch vehicles and Satellites having are propulsion elements. At present, launch vehicles are powered by solid, Earthstorable liquids as well as very low temperature cryo



propellants. The next generation launch vehicles shall be using semicryogenic engines as well which is under advanced stage of development. Herein we will be using refined Kerosene (ISROSENE) as fuel and Liquid Oxygen as oxidizer. The present GSLV MK III has a payload capability of 4 tonnes to Geotransfrer orbit which shall be enhanced to above 5 tonnes by introduction of the semicryo stage along with uprated C32 cryo stage. It has the advantages of higher specific impulse compared to earthstorable propellant combination, as well as lower cost in long run. Further, ISRO has also initiated development of a 100 Tonne LOX Methane engine which shall be powering our future launch vehicles of ISRO. A host of new technology initiatives like composite cryo tanks are being introduced to enhance the performance of existing propulsion stages.

Coming to satellite propulsion, so far we have been using only chemical propulsion for orbit raising and attitude control. Now we are envisaging fast track development of Electric propulsion thrusters for satellites which have higher efficiency and overall weight reduction which shall enable larger useful payload fraction in satellites. An All Electric propulsion system consisting of a 300mN thruster is in the final stage of development and shall be tested in a mission scheduled in the early 2023. We are also developing a new technology by name RF driven Plasma Thruster which can develop thrust ranging from 300mN to 700 mN for spacecrafts. The world is presently moving towards green propellants and ISRO too is developing both monopropellant and Bipropellant green propulsion thrusters initially of course for the Gaganyaan program and shall be used in future missions.

What are the specific problems identified under the Space based theme that is being discussed by the engineering community over the two days that have passed?

More than problem identification, the discussions are basically about how to improve the existing ways in both sustainable space programme as well as output oriented manufacturing.

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In Space, over the years, ISRO as an organization has made remarkable output but now, time has come to graduate to the next level by expanding horizon of space industry. This can be made possible only with the active involvement of our private industries and startups and providing them a conducive environment/ecosystem to fair in space. As this is an extremely technology intensive area, extensivehandholding will be required initially to expand this space business. We had extensive deliberations last 2 days, how to make this possible in a streamlined manner and worked out viable models for the same. Further ISRO has established number of state of the art facilities over the years and we are also working out methods by which genuine private players can make use of these facilities without of course compromising quality and safety aspects and the strategic nature of whole set up.

Are the manufacturing practices followed by ISRO on par with the global sustainable manufacturing methods?

As answer to your question, the present manufacturing practices followed in ISRO are definitely in par with global standards as Space is an area which does not tolerate any defectives or second grade products. Space manufacturing unlike others is challenging for the reasons that 1) It is highly quality intensive with micron level tolerances and expensive raw materials. 2)Requirement of products/year may be low for any private industry to cross a break-even level and make profits. Notwithstanding above, ISRO has identified industries both in Public and private sectors to make our products of intricate shapes and designs. Now coming to second part of your question, to achieve sustainability, we need to scale up this manufacturing activity to the next level and that is being deliberated in this Conclave. Towards this, we need to have more space missions by private parties as well as we need to produce space products for a global market. We have abundance of skilled manpower in our country and we need to device systems by which the world looks towards us for

manufacturing their space products and we shall be able to cater to their high end quality requirements. Further, newer manufacturing methods like Additive manufacturing is going to be adapted in ISRO centres as well as we will be enabling private industries to establish newer and better methods. The conclave has deliberated into many such business models by which these results can be achieved.

Panel Discussion A & B

Space for National Development



Policy interventions for manufacturing



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