



ALUMNI CENTRE  
BENGALURU

# **THE IIT-INDUSTRY CONCLAVE 2020**

FEBRUARY 7-8, 2020 | BENGALURU





## CREDITS

### RAPPORTEURS

Dr. Dhanajaya Dendukuri,  
Founder Achira Labs (Biotechnology Panel)

Mr. Anand Talwai,  
Member Governing Council IITACB (ICT Panel)

Prof. S. Gopalakrishnan, IISc. Bengaluru  
(Aerospace Panel)

Mr. Siddarth Das, Venture East  
(Manufacturing Panel)

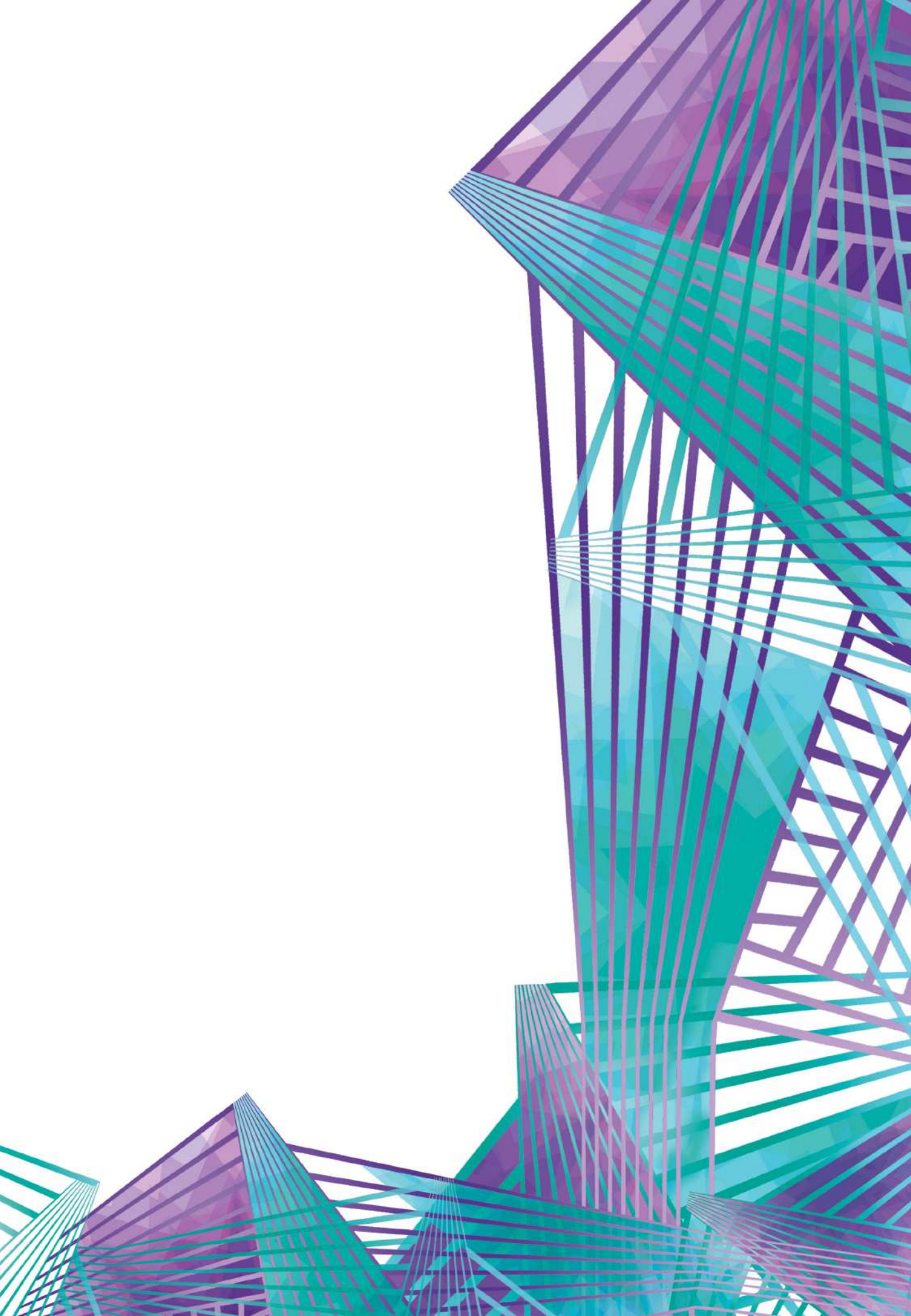
### EDITORIAL

Dr. Susheela Venkataraman, IITACB

Mr. Ashok Kamath, IITACB

### DESIGN & PRODUCTION

Ms. Sushmita Ananth







# CONTENTS

Foreword	5
Executive Summary	8
The Context	11
#DirectorSpeak : The Indian Institutes of Technology	28
Biotechnology	32
Information & Communications Technologies (ICT)	37
Aerospace	45
Manufacturing	52
Way Forward and Plan(s) of Action	57



The Indian Institutes of Technology are Institutes of National Importance and have lived up to their expectation over the 60+ years of their existence. They have outstanding faculty and students with a curriculum which is widely acknowledged as among the best in the world. In the early years they gave greater stress on teaching programmes, while in the last two decades the stress on research has increased several folds. This has resulted in high quality of research and graduation of a significantly larger number of Doctoral degrees which was much needed for India.

The importance given to research was recognised and the second generation IITs started during 2008-09 established research facilities right away along with developing innovative curriculum. The interactions between the IITs and the Industry did increase in the past two decades but much more is needed to harness the knowledge that exists in the portals of the IITs for the future growth of industry. The synergy between Industry and the IITs would be mutually beneficial and a great boost for our country, especially in the era when stress is on Make in India and Aatma Nirbhar Bharat.

With an aim to create a community to promote social and professional networking among the members and the world around, the IIT Alumni Centre Bengaluru (IITACB) was formed by a group of IIT Alumni to give back to the country in a unique way. The major goals of IITACB are: to act as a nodal agency for interaction between Industry and the IITs as well as to provide a platform for

partnering among industry leaders, IIT alumni, staff and students, and various departments of Government in furthering projects of local and national interest. IIT Alumni have contributed to India, and in fact, the world in several ways.

We now plan to be the facilitators for enhancing IIT-Industry interactions with sharing of knowledge and expertise. In order to take our goals to the next level, the IITACB organized the first of its kind IIT-Industry Conclave on February 7-8, 2020. This brought together people from the Industry, the Government, the IITs and leading Alumni to deliberate on issues that would boost the research and development activities with a flow of projects from the Industry and the Government to the IITs.



The Conclave also showcased the intellectual powerhouses of the IITs and their desire to take their relationship with the external world to greater heights. The areas selected for the Conclave were: Information & Communications Technology, Biotechnology, Aerospace and Manufacturing.

There were outstanding deliberations in all the panels and they made recommendations for the way forward that have been articulated in this report. We aim to have future Conclaves to cover other areas in a similar format.

Following the Conclave, we plan to facilitate mission-oriented research projects that could be undertaken at the IITs along with the Industry and have started work in this direction. IITACB wants to play its part for putting India on the road to becoming a \$5 trillion economy and more.

On another matter, the building of IITACB is an advanced stage of construction and we hope to hold future programmes on our premises.

I am privileged to lead this effort as the Founder President of IITACB.



- Ashok Misra





Day One of the conclave began with two Plenary addresses. The first was by Dr. V.K. Saraswat, Member, Niti Aayog and former Chief Scientific Advisor to the Indian Minister of Defence. He highlighted India's huge developmental challenges including those with respect to the Sustainable Development Goals (SDGs). While large strides have been made already, there is still much to be done. Where the best impact has been achieved, collaboration between academia, the research labs and industry has played a key role. Industry 4.0 is the next big focus area for India. He outlined in detail the specific actions for all players in the ecosystem.

The second keynote was by Mr. Nandan Nilekani, Co-founder and Non-Executive Chairman of Infosys. He took the specific example of the "India Stack" with its three-layered *"Identity - Payment - Data Empowerment"* architecture. He explained how this initiative has been able to take India's billion+ population forward on many counts and how this platform has enabled the implementation of super large-scale systems, which even other developed countries would like to replicate.

He called out the fact that solutions for India have to be based on thinking that is unique to India. Political will, and collaboration between several agencies have been key factors in the success of the initiative over the last 10 years. Industry and academia have worked together seamlessly and tirelessly. None of this would have been possible without the passion to do great things that brought several tech expert volunteers to the project, many of them being IITians.

Day Two of the conclave started with a special panel #DirectorSpeak with Directors of Five IITs (3 from the first and two from the second generation) and several in the audience. Thereafter, there were four industry thematic sessions on Biotechnology, Information & Communications Technology (ICT), Aerospace and Manufacturing.



The IIT Directors panel discussed the manner in which the 23 IITs have been evolving from first to second and third generation IITs, bringing changes in curriculum to keep with the changes in technology and industry needs and incubating tech start-ups. Projects for industry are now commonly carried out. There is a lot more flexibility in course offerings as well. However, there is still a lot more that can and should be done. Many ideas and suggestions were discussed in areas such as technology creation, translational research and thought leadership. Students coming out of the IITs should be well-rounded, not just excellent at technical knowledge but also understanding the big picture and their role in it. How the IITs are going beyond just technology and creating social impact was also discussed by several of the Directors. Specific actions and ideas pertaining to faculty, students, curriculum and relevance in the geographical area in which they are based were also considered openly.

There were four industry panels in the areas of Biotechnology, Information & Communications Technology (ICT), Aerospace and Manufacturing. Each of the panels discussed the current state of the industry and the progress that India has made in that segment. They also discussed the opportunities and challenges that they face and what could be done about it, especially in collaboration with the IITs.

Every panel discussed what goes into the making of successful initiatives. Mission-mode goal-oriented projects have succeeded. There is a need to think, design and work across disciplines. Solutions are not just about technology. Economic, social, sustainability and legal aspects also need to be considered. Especially in India, solutions need to be able to scale to cover very large population groups.

One key idea that came up time and again throughout the conclave was that of collaboration. Ideas for collaboration across IITs, as well as within the academia-industry ecosystem, relevant to problems being solved, were discussed. Several successful models were presented and ideas for replicating them were mooted.



It is evident that the full expertise is not fully appreciated by the industry and a sea change has to come about for this. It general, it became evident that the relevant industry should identify challenging problems for the IITs (one or more) to take up as projects - in some cases on a mission mode. The role IITACB will play is to facilitate this process. The conclave ended with the house, led by Mr. Kris Gopalakrishnan, evolving a high level Strategic Action Plan addressing specific sector programmes, best practices in the IITs and participation of industry in collaboration with the IITs in technology development. Work is in progress to identify specific projects from the industry that will challenge the IIT Academics.

The Conclave was graced by the presence of Directors from nine different campuses of the Indian Institutes of Technology plus three former Directors. Besides this, there were other Faculty Members from almost all the IITs and from IISc. The panels also had an eminent galaxy of speakers both from the academic community and from industry. It is a tribute to their commitment that these panelists had all worked towards making this Conclave meaningful, for a period of no less than three weeks prior to the Conclave. IITACB hopes to count on their continued support in the follow-up phases as well.





# THE CONTEXT:

## IIT-Industry Collaboration for Transforming India

The 23 campuses of the Indian Institutes of Technology (IITs) have been known for the excellence of their Faculty, Students and Alumni. The large number of Alumni of the IITs have a stellar record of performance across the globe. It is estimated that IIT Alumni are responsible for over \$ 1.5 trillion of budgets annually across companies and other organizations. It is now time to create a structured convergence between the IITs and Industry so that companies can benefit from the intellectual powerhouses that the IITs are; and, create next generation products and services that can catapult India on the path to the national aspiration of being a \$5 trillion economy by 2025. It is with this focused goal in mind that IIT Alumni Centre Bengaluru (IITACB) hosted the first of its kind IIT-Industry Conclave 2020 in Bengaluru on February 7-8, 2020.

*How IITs and Industry can accelerate collaborations together to make a significant difference to our national economy so that we achieve a GDP of \$ 5 trillion by 2025.*

There are several segments in the Industry that need greater attention from the IITs to develop technologies; and, from Industry to convert these technologies into products and services. For example, Information & Communications Technologies (ICT) could make a huge difference to the lives of millions of our fellow citizens by providing identities, benefits, facilities etc., in a seamless and painless manner. Other examples could be Aerospace and Manufacturing segments which would give us the strategic independence and the ability to compete successfully with global players. Healthcare remains a top priority and the Biotechnology segment would play a significant role for improved medical attention for people at large.

According to the Office of the Principal Scientific Advisor to the Government of India, Indian R&D spends are over Rs 1 lakh crores a year but it is still between 0.6-0.7% of GDP - other countries like the United States and China spend around 2.5% of GDP on R&D. Clearly, we need to ramp up and require a strong collaboration and linkage between the IITs and the Industry.

**IITACB had invited two eminent personalities to deliver the Plenary Talks:**

**Dr. V.K. Saraswat, Member of Niti Aayog** was the first speaker and he brought out many facets of the Indian economy, its growth, our needs and he shared thoughts as to what the IITs and Industry could do together.

1. In the first 25 years after independence, the government had set up infrastructure and institutions, as a result of which, industry and capability in the country grew. The green revolution took centre stage in the 1970s and white revolution in the 1980s. This was followed by progress in sectors such as Space and Defence, Pharmaceuticals and IT / ITeS. Despite all this progress in Science and Technology, the bottom of the pyramid has not fully benefited.





2. There are tremendous challenges the country faces in several areas. Despite initiatives such as Design and Make in India we are still 68 out of 141 in the Global Competitiveness Index<sup>1</sup>. Several industries are highly dependent on imports.
3. To achieve a growth from a \$ 3 trillion to \$ 5 trillion gross GDP we have to take advantage of digital technologies. While our share of global GDP has doubled in the last two decades we still need to develop markets for Digital Technologies.
4. We have a large and deep labour force which will be of advantage as we launch Industry 4.0.
5. The country faces major problems in areas such as energy security, population, the environment, transportation, health and urbanisation. Solutions will only be possible if Industry, Civil Society, and Government work together with Science & Technology as the common denominator.



1 [https://en.wikipedia.org/wiki/Global\\_Competitiveness\\_Report#2019\\_rankings](https://en.wikipedia.org/wiki/Global_Competitiveness_Report#2019_rankings)

The country needs to focus on the following priority areas:

1. Design and Make in India with a focus on Industry 4.0
2. Increase Agricultural production
3. Internet of Things (IOT) leading to a complete digital economy
4. Education 4.0 and Skills Development especially upskilling to be addressed
5. Export-oriented Enterprises
6. Clean and efficient energy systems
7. Better transportation and logistics
8. Smart Cities with smart infrastructure
9. Cyber security
10. Defence and Aerospace

### ***Innovation is the economic currency for this century***

India must work towards the “convergence of disruptive technologies”. He estimated that disruptive technologies such as biotech, genomics, microelectronics, additive manufacturing, the internet, robotics and renewable energy could contribute up to \$ 11 trillion to the global GDP.

Indian manufacturing has to become innovation-led and produce high value products. For this, there are several gap areas in Indian manufacturing such as customisation, real time response, predictive maintenance, and, self-configuration; we need to build the capability and focus in all of these areas. The transition to Industry 4.0 will mean large-scale adoption of new foundational technologies such as big data, cloud, industrial mobility and security.





*Creativity is the new gold*

Education 4.0 and Industry 4.0 have to be aligned closely so that social pain due to the lag between progress of technology and the products available can be mitigated. A few parallels are given below:

Industry 4.0	Education 4.0
Flexible production lines	Tailormade learning paths
Online quality assessments	Formative assessments
Worker monitoring	Teachers as mentors
Custom products and systems engineering	Lifelong learning both for teachers and students

**AN ACTION LIST FOR THE IITS**

1. Instill the 4C's in the students - Collaboration, Communication, Critical Thinking and Creativity
2. Compulsory education in ICT for all students in all disciplines
3. Education content must be created and modified in collaboration with industry. To make this happen, both the content and methodology of education must use digital platforms.
4. The IITs and industry need to work together closely in some areas of research such as light-weighting which will require work on materials; 3D printing and 4D printing and additive manufacturing; automation and robotics; monitoring and control and human-machine interface; simulation and modelling using advanced design and modelling software
5. Top researchers in the IITs should be tasked with leading Global projects.



For the Creative Employee of Industry 4.0, technical skills are not enough: innovation, management skills and fast instinctive response are important too.

- 1. Our problems require very complex socio-technical solutions which can only be achieved through multi-disciplinary working.
- 2. It is important to be able to adapt to Rapid Innovation Systems and as the half-life of knowledge keeps reducing, the ability for lifelong learning is paramount.
- 3. IT skills are “Survival” skills and will be the main driver of future innovation. Having said that, a basic understanding of all other disciplines is just as important.
- 4. Engineers need to understand new business thinking including how to communicate business ideas to different stakeholders and how to collaborate in the Global Village.

There has to be a close collaboration between Government, the IITs and Industry for industry 4.0 and Education 4.0 to be aligned.





New age R&D: the mantra again is Industry-Academia Collaboration.

The transition from the traditional to the R& D of tomorrow will require ideation, collaboration, cross-functional working and organisation connectivity. Entrepreneurship will play a pivotal role in this endeavour.

With conflicting goals, Industry-Academia Collaboration often does not work well. Industry is driven by stakeholder value-the realisation of commercial returns and the protection of ideas. Academia on the other hand, is driven by basic research, educating the citizen of the future, and publishing research to enhance knowledge and reputation. For the new priorities, we have to find a model that would be attractive to both industry and academia. In such a model:

1. The incentive for Academia is increased access to funding, access to business insights and practices and increased reputation.
2. The incentive for Industry is access to academic expertise and publicly funded resources, the latest research insights, new methodologies, training for potential employees, reduced cost of research and the ability to influence Research and Education programs.

## AN ACTION LIST FOR GOVERNMENT:

1. Increase investment in basic research in all sectors.
2. Increase investment in translational research.
3. Provide students with access to innovation centres and incubation centres
4. Invest in commercialization by promoting early-stage investment in innovation until value is realised
5. Improve small business research and technology transfer programmes



## AN ACTION LIST FOR THE IIT SYSTEM

1. Standardise terms and conditions for research and licence agreements in particular for IP management.
2. Demonstrate successful models of Academia-Industry Collaboration projects
3. Set up core technology facilities and provide free access to these facilities.
4. Top Notch entrepreneurs in residence in the IITs.
5. Encourage postdoctoral work to lead to commercialization.
6. Host engineers from industry on deputation to enable demand-driven research and development.

## AN ACTION LIST FOR INDUSTRY

1. Provide fiscally prudent funding
2. Advise on industry needs
3. Joint programmes with government and the IITs in grand challenges relevant to India
4. Invest in in-house research in India.
5. Encourage academics to work in industry-owned R&D set ups.
6. Value Creation Centres: Nothing is possible without collaboration. To this end, issues such as trust building, sound IP management, realistic valuation and timely delivery must be focus areas.

It is suggested that the "technology transfer office" is converted to a "value creation centre" that serves as an active gap filler between industry and academia.





The second Plenary Speaker was **Mr. Nandan Nilekani, Co-Founder and Chairman of Infosys Technologies Limited and Chairman of Ekstep Foundation**. The theme of Mr. Nilekani 's keynote was democratization of the digital economy. He described the huge digital transformation that has helped India leapfrog in terms of financial inclusion of the less privileged in a very big way. The three big ideas that form the basis of this transformation are: Identity, Payments and Data Empowerment. This decade-long project has been possible only because of close collaboration between IIT alumni, the government and industry.

The three challenges with respect to financial inclusion are : access which is about bringing the population into the financial system; retention which is keeping them in the system; and, finally, data empowerment which helps people use their data for their own purposes without compromising their privacy .



India's answer to this, the "India Stack", consists of three layers: an identity layer which enables every resident to get a unique ID and the ability to prove their identity (Aadhaar, e-KYC, and e-sign). The next layer is the payment layer which allows anyone to pay anybody else. This layer allows for interoperability and inexpensive transactions. Aadhaar enabled payment services and the Unified Payments Interface (UPI) are the key elements. Finally, the data empowerment layer allows secure sharing of data. For this, consent to use the data, a digilocker and account aggregators are required.

## *Identity*

In 2008 when the Aadhaar effort started, only one in 25 Indians had a Unique Identification. The 12-digit Aadhaar number has four very simple data points (the name, date of birth, gender and contact details) and biometrics which in India are the only feasible unique Identification mechanisms, as everyone does not even have a birth certificate. Aadhaar adoption in 2011 was at 100 million and went up to a billion in nearly five and half years and 95% adult Indians now have a unique identification because of this.

The biometrics de-duplication for determining uniqueness called for a massively parallel computing exercise. For example, if 1 million people were enrolled in a day and 500 million people were in the database then 500 million pattern recognition matches had to be made to establish uniqueness of biometric of each individual. This required a highly complex and sophisticated technology solution and an unprecedented scale of implementation.

Aadhaar as a unique identity has had tremendous impact . 647 million Aadhaar-enabled accounts have been opened , 33 billion Aadhaar-based authentications have taken place, 7.5 billion e-KYC transactions have been possible and USD 32.4 billion worth of direct benefit transfer to beneficiaries made (as on January 2020).



## *Access to the financial system*

In 2008, only 17% of Indian adults had bank accounts. By 2011, a little over 20% adults had a bank account; this was more or less in line with the global scenario of the number of people with bank accounts in proportion to the per capita GDP. However, by 2018, about 80% Indian adults had opened bank accounts. This was well ahead of the global curve. With traditional development, it would have taken 46 years to get to this stage.

This tremendous acceleration was possible only because of three factors: political will, a proactive Central Bank in RBI and technology that was built to enable all of this to happen, the “India Stack”. This massive technological intervention that enabled India to leapfrog in just eight years was completely indigenously designed and developed in India.

Aadhaar has enabled financial inclusion in a very big way. Even in remote areas, people can withdraw money using Aadhaar enabled payment services. Starting with Aadhaar and IMPS in 2009, it has taken 10 years to get to realisation of the idea of a data fiduciary through account aggregators.

Further, with Aadhaar in place, several empowering initiatives have been possible. For example, using e-KYC, it is possible to instantly get several services from different service providers. It is now possible to digitally sign using the same one identity.

A survey of 167,000 people in 28 states and Union Territories, which was published in “The State of Aadhaar 2019 edition” showed that 80% of beneficiaries feel that Aadhaar has made PDS rations, MGNREGS or social pensions more reliable, 92% were either somewhat or very satisfied and people using Aadhaar are 40% more likely to obtain a new SIM card within one day.



## *The link to banking systems : Payments*

Payment systems should keep people in the financial system by providing adequate and efficient services. The UPI (Unified Payment Interface) mechanism was designed to allow for a MAGICAL payment experience- that is, Mobile first, Anytime, Global, Instant, Convenient, Assured safe and Low cost. UPI allows for interoperability between different sources of funds that is between multiple banks, B2B, C2C and C2B payments as well as instant remittance which means interoperability between the recipients of funds. This has allowed several unregulated fintechs such as Google Pay, Samsung Pay, Phone Pe and PayTM to evolve.

Since the payment systems of the banks are fully interoperable, customers can conduct transactions on their bank accounts from inside the mobile banking application of any other bank. It also allows them to send money through apps such as WhatsApp which are widely used all over the country.

The cash transfer program of the government is the world's largest ever. So far 647 million people have benefited from this programme. LPG subsidy, scholarships, kerosene, fertilizer subsidies etc., can be done away with and instead the product or service can be purchased by the beneficiary at market rates. This is a definite transformative step for the country's economy as it helps the country move away from subsidies and get money to the most vulnerable so that they can buy the services that they need.

The government's empowering initiatives, such as direct benefit transfer have long been fraught with issues such as fraud. With the implementation of straight-through processing, cutting across multiple banks' systems and government systems, it is possible to transfer funds in real time to the beneficiaries' accounts. This takes away intermediary frauds that might happen.





The government by now has transferred over US \$32 billion into the accounts of the underprivileged. India has become a global benchmark for payment systems. China has a duopoly with Alipay and WeChat.

However, in India, the system caters to an extremely competitive payments market where several banks compete and so do many frontend applications. There is a huge choice for the consumer which helps bring down the cost as well as drive innovative solutions.

While there are 1.3 billion transactions per month now, amongst the largest transaction volumes anywhere, it is expected that the system in the next few years will cater to 1 Billion transactions per day. In 2017-18 UPI was used for 4% of transactions whereas UPI transactions accounted for 17% of transactions in 2018-19. Within 3 years of launch, UPI transactions have overtaken credit and debit card payments as of October 2019.

The BIS has chosen this model as a benchmark for the world. In the USA "FedNow" is the equivalent platform which is due in 2024. Google has suggested that it can be modelled on India's UPI.

## ***Data democracy***

India is leapfrogging to becoming a data democracy.

Data empowerment is a concept that is unique to India, which has not been implemented anywhere else in the world. Data is a way of life: we are inundated by a tsunami of data on a daily basis. Globally, companies use it to become profitable using E-Commerce and Advertising and governments use data for policy decisions and implementation. But can data be something that benefits individuals and small businesses? This is a profound idea and an Indian innovation. It has been jointly enabled by government, the private sector and regulators.



The concept is realised using the idea of account aggregators. RBI would be the regulator for financial data. Similarly, there would be regulators for different sectors such as IRDA for the Insurance Industry, SEBI for the stock markets, etc.

The challenge of data empowerment is how to allow people to share their data for their own needs without compromising their privacy. We know that companies have been using the data of their users to benefit their own businesses; however, the people who own the data are unable to gain from the same. The “account aggregator”, who is essentially a consent manager, will re-balance that equation.

The financial data of users resides in systems such as those of banks, mutual fund houses, insurance providers and tax authorities. The user can request for any specific pieces of her data (through an open API ) to be sent to financial information users such as Wealth Management Advisors, Personal Finance Management providers and Robo Advisors. The user provides consent to the account aggregator to share the data by specifying the use of that data, as well as the duration for which the data may be shared. Consumers can selectively share and revoke data as and when they would like to. The account aggregators have a fiduciary duty to consumers. The data is encrypted and goes at the behest of the user to the specific service provider. The account aggregator therefore cannot see the data and cannot profit from storing and selling it.

This model will allow new business models to evolve, such as flow-based credit based on business performance as against the traditional asset based credit. It is expected that millions of dollars of lending will happen as a result, empowering many small businesses. These systems offer new tools to regulators as well, as they can have early warning systems and allow for more precise regulatory intervention as required. The legal and regulatory framework have also been put in place to enable individuals to access their own data for themselves and this is being embedded into the privacy law as well. Presently, one account aggregator has an



operational licence and 10 financial information uses have already been launched by leading banks and NBFCs. The architecture supports any kind of data. Financial data is the first instance that is being implemented, but it could also be skills, health, etc. Thus, for realisation of the idea of data empowerment, three parts have to work together: the account aggregator framework, the legal system and the technology to get real time data from any source to any destination.



### *Implementing the India Stack*

The India Stack is indeed a powerful transformative platform.

Just as on top of the single internet infrastructure, government services, information discovery, social networking, e-commerce etc are carried out across the globe, the single India Stack allows for multiple innovations. Digital lending, tax reforms,



much faster payments, health insurance, financial inclusion schemes and direct benefit transfers have all been possible only because of the existence of the India Stack infrastructure.

Unlike traditional end-to-end systems, this kind of innovation requires a strong platform architecture. The old way of working involved closed systems. Banks, clearing houses and the central bank would have their own systems. On the other hand, the big tech approach is that of a walled garden with layered innovations such as Crypto wallets, stable coins and blockchain. The India Stack way is the middle path, which is development friendly and involves layered innovation with regulated players and unregulated fintechs providing services across the country.

A platform architecture is the only way such an aspiration to enable the inclusion and empowerment of the entire nation can be realised. This approach helps to resolve dichotomies and apparent trade-offs as well. It is possible to think simultaneously of regulation and innovation, privacy and personalization, ease of use and fraud prevention. Nation-wide population scale interventions take a lot of time.

They also require strategic thinking and a strategic way of rolling out. Here, initiatives were layered one on top of another, over more than a decade. The success of the India Stack was possible only because of collaboration and close working across agencies, not only within the government but also with industry and academia. The initiative remained a focus across different governments as well.

IIT alumni and IIT professors have been deeply involved in this exercise. Industry too has been involved in many areas. There have been several excellent outcomes of these collaborations. Today, India has the lowest cost in biometric technology, thanks to the scale of implementation required here. Expertise has increased in various areas such as Artificial Intelligence which was used extensively for critical areas such as face authentication.



## *Potential for Research and Technology*

There are several opportunities for the IITs to participate in a very big way. Artificial Intelligence for fingerprint recognition, GST systems, etc must be developed. Neural machine translation in an open systems mode has to be put in place to help with multi-language processing capability.

### **Key messages**

1. The latest technology can help us leapfrog several decades.
2. Indigenous technology capability exists.
3. Collaboration is the name of the game: across disciplines and across agencies.
4. Passion, hard work and imagination made what seemed a dream come true.
5. Large population level interventions require thinking boldly, architectures designed for the whole system, long term focus, political will and the participation of people.
6. Indians can design and develop world-leading solutions and set standards for the world.



# #DIRECTORSPEAK

## THE INDIAN INSTITUTES OF TECHNOLOGY

The IIT Directors Panel was led by Prof. Rishikesh Krishnan, former Director of IIM Indore and himself an alumnus of IIT Kanpur (as of this writing, Prof. Krishnan has been appointed Director, IIM Bangalore). There were five serving Directors of the IITs - three from the first generation IITs and two from the second generation. And they brought out varied viewpoints that all converged into a few topics.





The IIT Directors panel discussed the manner in which the 23 IITs have been evolving from first to second and third generation IITs bringing changes in curriculum to keep pace with the changes in technology and industry needs and incubating tech start-ups. Projects for industry are now commonly carried out. There is a lot more flexibility in course offerings as well. However, there is still a lot more that can and should be done. Many ideas and suggestions were discussed in areas such as technology creation, translational research and thought leadership. Students coming out of the IITs should be well-rounded, not just excellent at technical knowledge but also understanding the big picture and their role in it. How the IITs are going beyond just technology and creating social impact was also discussed by several of the Directors. Specific actions and ideas pertaining to faculty, students, curriculum and relevance in the geographical area in which they are based were also considered openly.

Prof. Rishikesh Krishnan began by asking the Directors to speak on two key issues:

- (a) What, in their opinion, have the IITs done well and what could be considered as reasonable expectations of the IITs.
- (b) Focus on the future especially on technology development challenges.

**Prof. V. Ramgopal Rao, Director of IIT Delhi** felt that the IITs have been evolving. In the early years the focus was on producing trained engineers and therefore the emphasis was on teaching and curriculum. Now, there is a significant shift to adding research capabilities and in campuses like IIT Delhi more than 60% of the student body is pursuing postgraduate work. Research has also enabled IIT Delhi to file for patents and build a body of Intellectual Property, and, now the focus is shifting to monetizing this intellectual property effectively. Start-ups with roots on the campus is also key and the curriculum is being tailored to gear to this. Eventually, “we would like to see a thousand start-ups emerge from the campus”, he said.



**Prof. Timothy Gonsalves, Director IIT Mandi** talked about the challenges of setting up an IIT campus in a region where there is very little industry. He had a small presentation that talked about the evolution of the IIT Mandi campus and the tailoring of the curriculum to bringing in innovations such as project-based team learning and introducing data sciences as a discipline at the undergraduate level. IIT Mandi is also paying attention to the social impact of technology, while, simultaneously, working with leaders in industry such as Intel Corporation and SCL Mohali. Prof. Gonsalves's presentation can be seen at:

<https://drive.google.com/drive/folders/1YzjFMOEgzWMuMyif9JogxuJtlbtBoyDW>

**Prof. T. G. Sitharam, Director of IIT Guwahati** also extended this to share the experiences of IIT Guwahati and its evolution over its 25-year history and his presentation is available at :

<https://drive.google.com/drive/folders/1YzjFMOEgzWMuMyif9JogxuJtlbtBoyDW>

In his narrative, IIT Guwahati stood for Innovation, Incubation and Translation for Growth.

**Prof. Abhay Karandikar, Director of IIT Kanpur** also added to the narrative of IITs moving from teaching to research over the past three decades. There has been a significant move to technology development, research and incubation. However, he believes that a lot more can be done and this needs a strong pull from industry to get more done at the IITs. Entrepreneurship as a discipline is now being "taught" at IIT Kanpur; moreover, incubation of start-ups is an important activity and this can only grow over time.

Finally, **Prof. Sudhir Jain Director IIT Gandhinagar** began by bringing out an interesting non-technical facet of the IITs - that the IIT system has done extremely well on integrity. And that all of us in the IIT system should take pride in it. The IITs have also done well in pivoting from a purely teaching role to one that includes research as well.



He pointed out that IITs have done 10x better than all other institutions; however, the IITs can do 10x more than what has been accomplished so far. He lamented a lack of uniform academic culture and also mentioned that government and corporates looked at the IITs through their own lenses which was not appropriate. IITs are academia and they should be looked at not as civil servants or corporate honchos.

Asking each of the panelists to summarize in one line, they said:

Delhi:

**"Relevance and Delivery (as in R&D) should be significant."**

Mandi:

**"Involve Industry"**

Guwahati:

**"Need peer reviews for Faculty Members when it comes to promotions."**

Kanpur:

**"Build a unique culture and accountability to society."**

Gandhinagar:

**"Director should have a few talented people around him called Advisors - Industry Partnerships."**





## 32 THEME FOR THE **BIOTECHNOLOGY** SESSION

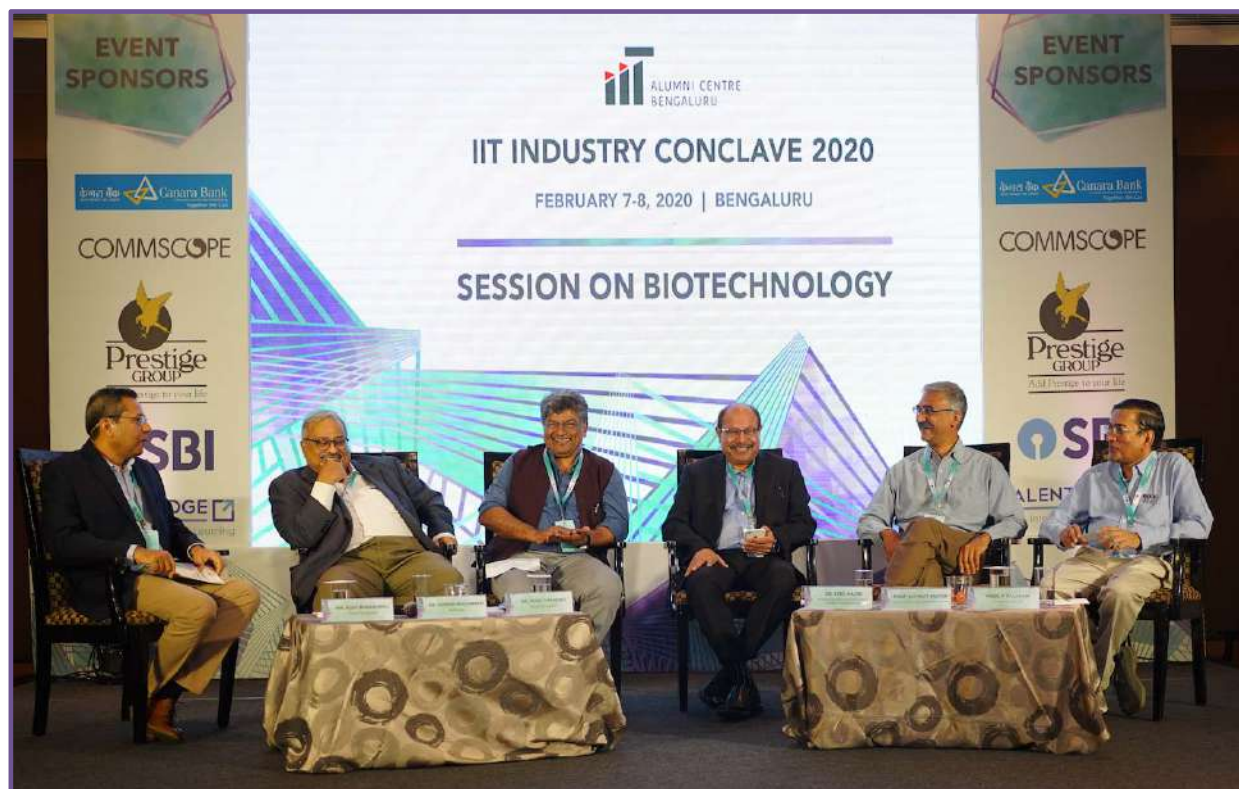
*The biotechnology wave is similar to the information technology wave of the 1980s and 1990s.*

*- Dietmar Hopp, Co-Founder, SAP*

The biotechnology sector of India is highly innovative and is on a strong growth trajectory. India has the second-highest number of US Food and Drug Administration (USFDA) approved plants, after the USA. Out of the top 10 biotech companies in India (by revenue), seven have expertise in bio-pharmaceuticals and three specialise in agri-biotech. The Indian biotech industry holds about 2 per cent share of the global biotech industry. Biopharma is the largest sector contributing about 62% of the total revenue followed by bio-services (18%), bio-agri (15%), bio-industry (4%), and bio-informatics contributing (1%). India has emerged as a leading destination for clinical trials, contract research and manufacturing activities owing to the growth in the bio-services sector. India currently has a marginal share in the global market for industrial enzymes. Hence, there is an opportunity in focused R&D and knowledge-based innovation in the field of industrial enzymes, which can innovatively replace polluting chemical processes into eco-friendly processes that can also deliver environmental sustainability. Another interesting field of study is the area of bio-markers and companion diagnostics, which will enable optimising the benefits of biotech drugs.

*The Government of India plans to invest US\$ 5 billion to develop human capital, infrastructure and research initiatives to realize the dream of growing the sector into a US\$ 100 billion industry by 2025. How can the IITs and Industry collaborate to make this happen?*

The Biotechnology Panel was an accomplished one moderated by Mr. Ajay Bharadwaj, Founder and Chairman, Anthem Biosciences.



The panel included (from right to left):

- (a) Prof. P. Balaram, former Director of the Indian Institute of Science
- (b) Prof. Satyajit Mayor, Director of the National Centre from Biological Sciences (NCBS)
- (c) Dr. Syed Kazmi, President Jubilant Therapeutics Inc., USA
- (d) Dr. Vijay Chandru, Founder Strand Life Sciences
- (e) Dr. Suresh Madhavan, Founder and Chairman, PointCross Life Sciences, USA

Given below are key observations from the panel discussions as noted by the Panel Rapporteur, **Dr. Dhananjay Dendukuri, CEO and Co-Founder Achira Labs.**

### **Ajay Bharadwaj**

1. We need to focus on lowering the cost of many innovative therapies (Car-T/biologics/gene therapies) for the Indian context.
2. Start-ups should work with big pharma where they bring in the innovation, and, process from big pharma can help in eventual licensing
3. Use CSR money for funding incubators

### **Dr. Vijay Chandru**

1. Precision medicine studies with a focus on Indian population can yield long term benefits. We need to collect Indian patient genomes and focus on mutations specific to Indian populations. e.g., in breast cancer, BRCA1/BRCA2 mutations<sup>2</sup> in India are 80:20 vs 50:50 in the West as per data available with Strand Life Sciences.
2. We need to insist on archiving budget at the end of funded projects. Usually, data is collected but lost. It is recommended that we follow the National Data Sharing & Accessibility Policy of the Government of India which was approved by the Union Cabinet in February 2012. This can be the start to properly collected, curated data.
3. Incubators should focus more on translation of research from academics rather than being a site only for external companies

<sup>2</sup> The name “BRCA” is an abbreviation for “Breast Cancer gene.” BRCA1 and BRCA2 are two different genes that have been found to impact a person’s chances of developing breast cancer.



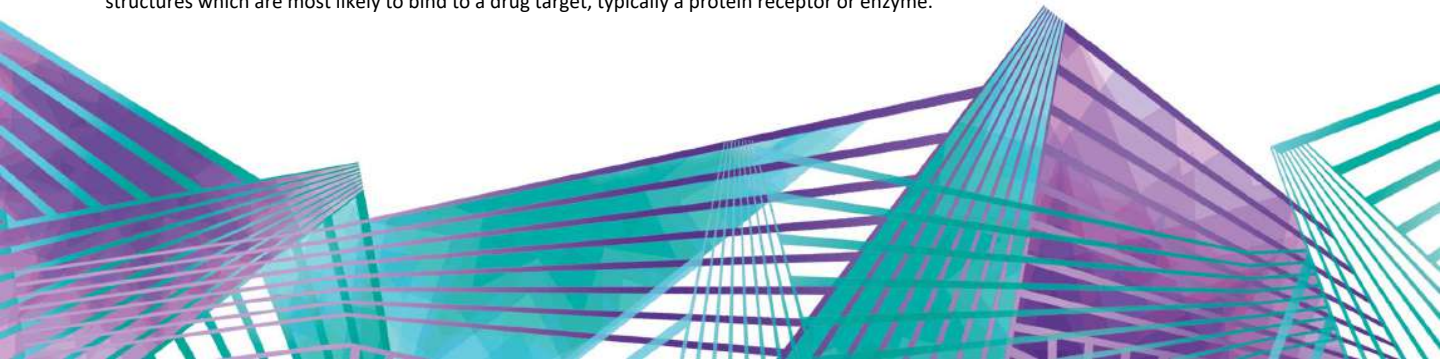


4. We need to leverage the Indian Institute of Science (IISc) to be the centre of multi-partner collaborative projects with the IITs as they (IISc) have a great research record and do both science and engineering

### Dr. Syed Kazmi

1. We should develop the next generation antibacterial/antivirals because of India's patient profile of tropical diseases. We should not blindly follow the Western model of oncology.
2. We need to use Artificial Intelligence techniques to build virtual screening<sup>3</sup>. This will have to be followed by getting patients for clinical trials.
3. We will need more collaboration between IITs and hospitals. Hospitals have EHR data. The IITs can collaborate with them to build algorithms to identify patients with distinct characteristics. e.g., resistance to leukaemia, why are they resistant? This may lead to finding mechanisms for personalized medicines going forward.
4. Pharmaceuticals manufacturing: Image processing can be very relevant in pharmaceuticals QC - simple Pass/Fail/Maybe tasks can be automated.
5. Gene delivery is very expensive. We need to explore and find better viral vectors for gene delivery, for example.
6. **App Idea** : Can we repurpose existing sensors for disease detection - e.g., microphone on the cellphone to detect Tuberculosis based on cough; or, accelerometers that pick up gait/tremors for Parkinsons, etc.
7. Can we get big pharma to fund incubators in a prize model. They then have a front row seat to innovation.

<sup>3</sup> Virtual screening (VS) is a computational technique used in drug discovery to search libraries of small molecules in order to identify those structures which are most likely to bind to a drug target, typically a protein receptor or enzyme.



**Prof. Satyajit Mayor**

1. We are still a very small community of researchers in the life sciences. Need a lot more investment and skill development to reach critical mass.
2. IITs have a major role to play because of the interdisciplinary role of biotechnology.

**Prof. P. Balaram**

1. Focus on green solutions for agritech given the climate-change/social/legal challenges. For example, biological control versus insecticide for pesticides.
2. Small companies should focus on drugs with easier regulatory paths, e.g., skin has a lower regulatory barrier
3. Biotech needs patient capital and long horizon times for biotech investments

**Dr. Suresh Madhavan**

1. It is now possible to have a completely virtual online marketplace model of drug discovery. It is now possible to design a molecule in a low infrastructure setting with access to free data. All development/trials can be outsourced and, once proven, it is possible to then license the molecule to big pharma.
2. Functional biomarkers like gait/tremors/pulse etc. are more amenable to software development. There is a large potential for Indian entrepreneurs in this space.



# THEME FOR THE **INFORMATION & COMMUNICATIONS TECHNOLOGIES (ICT)** SESSION

*India is so big. Maybe in 10 years, we can have a factory in every state.*

*- Terry Gou - Founder and Chairman, Foxconn*

India is currently the world's second-largest telecommunications market with a subscriber base of nearly 1.20 billion and has registered strong growth in the past decade and half. With over 625 million internet subscribers, India ranks as the world's second largest market in terms of total internet users. India is also the world's second largest telecommunications market, with a total subscriber base of 1,183.5 million at the end of March 2019. Over the next five years, rise in mobile-phone penetration and decline in data costs will add approximately 500 million new internet users in India, creating immense opportunities for new businesses. India is the leading sourcing destination across the world, accounting for approximately 55% market share of the global services sourcing business. Indian IT & ITeS companies have set up over 1,000 global delivery centres in about 80 countries across the world.

To retain a global edge requires more than just the size of our population. India needs to invest heavily on technologies such as Artificial Intelligence / Machine Learning / Deep Learning; on IoT; on Blockchain, on 5G technologies and beyond. There is a need to develop a robust ecosystem including basic infrastructure that allows innovation to flourish and create products for global consumption and achieve supremacy in key areas of technology. The Indian academic and research system led by the IITs could be a key driver in making this happen.

*Can the IITs and Industry working in tandem achieve \$ 500 billion+ in revenue in 2025 from the ICT segment?*



The ICT panel had an interesting mix of people with experience in technology, product development and policy making, and this panel was headed by Mr. Samir Kumar, Managing Director of Inventus India.



The panel included (from right to left):

- a) Prof. N. 'Balki' Balakrishnan, Iisc. Bangalore
- b) Prof. V. K. Tewari, Director IIT Kharagpur
- c) Prof. Uday Desai, former Director, IIT Hyderabad
- d) Mr. Arnob Roy, Founder and COO, Tejas Networks
- e) Mr. N. Krishnakumar, former Chairman Mindtree and NASSCOM



Given below are key observations from the panel discussions as noted by the Panel Rapporteur, Mr. Anand Talwai, Member Governing Council, IITACB.

As ICT is a very broad-based area, the panel led by moderator Samir Kumar had identified Artificial Intelligence (AI) and 5G as topics of discussion considering their big impact in the Indian context.

The panel focused on:

- (a) How Industry, the IITs and Policy Makers, with IITACB as a nodal point, could work together to enable India to take a leadership position in AI?
- (b) Can the next 'Huaweis' be incubated and build from India starting with 5G technology and beyond? What do we need to be careful about as 5G rolls out in India (security, etc)?

Discussions on Artificial Intelligence:

### **Prof. N Balki Balakrishnan**

Prof. Balki was a member of the Government of India Committee that worked on AI for strategic initiatives, research issues and hardware development. He has prepared for this Conclave a selection of areas where research/translational research needs to be done. See Appendix A for the list. His key inputs during the Conclave were:

1. In AI, we need to recognise social and legal issues, markets for speech and computer vision, and, next generation technologies.
2. We should look at intelligence enhancement rather than human replacement with AI deployment.
3. Data security is a key and sensitive area; how do we deal with it?



4. Intent is strong by the Government but execution is the key. Niti Aayog<sup>4,5</sup> has a budget for AI of Rs. 6,500 crores, and, in the recent budget the Government of India announced an allocation of Rs.8,000 crores for Quantum Computing.

5. There are many challenges in AI research. AI is still an aspirational technology. We have to address India-specific challenges. A lot of intellectual capital needs to be built and building blocks need to be developed in the IITs and IISc.

**Prof. Uday Desai** (Prof. Uday Desai's preparatory notes are in Appendix B)

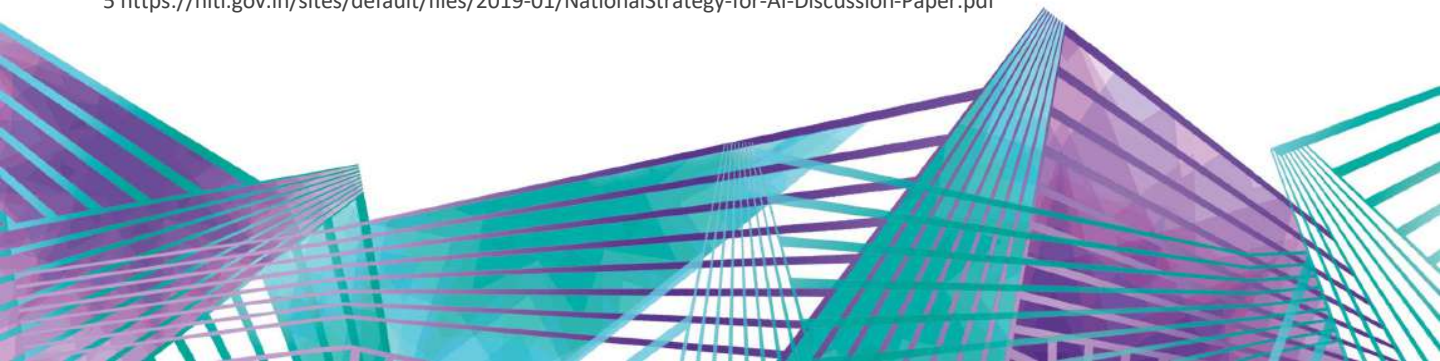
His key inputs were:

1. We should create a solution platform tailored to a specific industry segment rather than for a specific company
2. Explore the possibilities of private industry supporting the IITs financially under the CSR mode.
3. With institutions like CDAC and several IITs getting exascale computing capabilities, we should allow industry also to use these facilities for research purposes so that the infrastructure can have optimal utilisation.
4. Encourage the Government to make timely release of funding so that projects can be handled quickly before obsolescence sets in.
5. IITs should develop products and technologies in "Mission Mode" with well defined and monitored timelines rather than in project mode as is being done today.

He mentioned that IITACB has a clear role to create an enabling ecosystem and foster collaboration between Industry, IITs and startups for development in AI technology.

4 [https://dipp.gov.in/sites/default/files/Report\\_of\\_Task\\_Force\\_on\\_ArtificialIntelligence\\_20March2018\\_2.pdf](https://dipp.gov.in/sites/default/files/Report_of_Task_Force_on_ArtificialIntelligence_20March2018_2.pdf)

5 <https://niti.gov.in/sites/default/files/2019-01/NationalStrategy-for-AI-Discussion-Paper.pdf>





## Mr. N. Krishna Kumar

Mr. Krishna Kumar strongly believes that the market size where AI can impact is much bigger than the IT services market. Given this opportunity, he suggested that we should:

1. Look at the future and identify key industry problems. Have specific use cases where AI can be deployed for effective solutions.
2. Look at Aadhar-like projects where private sector governance is brought inside Government/PSUs. IITACB can play a role in skilling and re-skilling people by bringing the IITs to Bengaluru to re-skill employees in industry in and around Bengaluru.
3. Look at issues like ethical AI, policies, etc.
4. Look at AI relevance in specific use cases - build specific Centres of Excellence (CoEs)? Can the IITs work together through IITACB to make these CoEs better?

## Prof. V. K. Tewari

Prof Tewari stressed on three areas:

1. Increase translational research in IITs. Build on work already done / patents in AI area.
2. Seek voluntary contributions from Alumni in developing solutions.
3. IITs can focus on using AI for social impact, say, in agriculture.

## Mr. Arnob Roy

1. AI finds applications in healthcare, precision manufacturing, transportation, cyber security.
2. Solve problems of industry. Look at products, projects, processes.
3. Set a 3-year time frame to solve specific problems.



## DISCUSSION ON 5G TECHNOLOGIES<sup>6</sup>

### Mr. Arnob Roy

1. Mr. Roy strongly believes that it is essential to develop indigenous 5G technologies in a mission mode. India and Indians should be the owners of the technology. We have the ingredients of infrastructure and software stacks. It is important for the Government, private sector and academia to come together for technology development.
2. Apart from equipment makers, we also have to work with component makers like Qualcomm, Broadcom and others.
3. Security of 5G - owning key IP is critical.
4. To develop the entire ecosystem, Government funding of \$ 2-3 Billion would be required.
5. Market access to local companies to be provided. Access to standard patents is required.

### Prof. Uday Desai

Prof. Desai mentioned that some collaborations are happening. For example, there is a Rs. 230 Crore collaborative project between IIT Hyderabad and IIT Madras for a 5G Test Bed. Potentially, equipment makers and stack developers can use this. There is also some collaboration in the IITs with startups. He believes that we are forced to collaborate with MNCs and asks the question - How do we collaborate with Indian companies? We also do not have representation in global standards bodies. This needs to be remedied.

<sup>6</sup> [https://dot.gov.in/sites/default/files/5G%20Steering%20Committee%20report%20v%2026\\_0.pdf?download=1](https://dot.gov.in/sites/default/files/5G%20Steering%20Committee%20report%20v%2026_0.pdf?download=1)



## Prof. N. Balki Balakrishnan

His inputs focused on security issues.

1. Security of telecom equipment is challenging. Equipment security should not be compromised.
2. Stacks are to be securely protected. Make systems robust.
3. High focus on data security needed.

### GENERAL COMMENTS AND RECOMMENDATIONS:

The sense of the ICT Panel in the Conclave was to identify programmes to develop and deploy AI technologies to effectively and efficiently solve a (one or more) big India specific problem, and the development of indigenous 5G and beyond technologies. In both cases, solutions should also have a big social impact in India.

IITACB should function as a nodal agency that will bring together industry, IITs/IISc and any other relevant academic/research institutions, India based startups, incubation centres /innovation centres / Centres of Excellence in IITs/IISc, expert alumni, volunteers and representatives from regulatory agencies.

IITACB should identify two "System Integrators" anchored in IITACB to take identified initiatives forward and develop specific programmes. The programmes will have specific, time-bound outcomes defined and periodically monitored. Two names were "volunteered" - Vivek Raghavan as the Lead for the AI Initiative, and Arnob Roy, COO, Tejas Networks as the Lead for indigenous development of 5G Technologies programme.

Both Vivek Raghavan and Arnob Roy should have a core team consisting of IITACB members and members representing industry, IITs, IISc and startups. Core Teams will identify India-specific big challenges and solutions to be developed and delivered in a "Mission Mode" in defined timelines.





Core Teams will identify and develop specific programmes and come out with a high level Plan in next two months.

After discussion on this Plan, a consortium with representation of all stake holders and specific subcommittees will be formed to roll out the Programme.

Specifically they should focus on :

- (a) Mapping of talent in IITs,
- (b) Creating interface with funding agencies and regulatory bodies.
- (c) Specific Research Programmes to be identified.
- (d) Capacity building of requisite talent to be addressed.
- (e) Computing facilities, test labs and other assets in IITs and other agencies will be identified and accessed for technology development after necessary permissions are obtained.
- (f) Options of Industry funding, including CSR funding, will be explored.

Active participation of the industry and creating a pull-factor for the Solutions and reducing demand-supply should be the key parameters to the success of the programmes.



# THEME FOR THE **AEROSPACE** SESSION

*Look at the sky. We are not alone. The whole universe is friendly to us and conspires only to give the best to those who dream and work.*

*- Bharat Ratna Dr. A. P. J. Abdul Kalam, Former President of India*

Aerospace and defence manufacturing today is truly an emerging industry in India. At upwards of \$50 billion, India has one of the largest defence budgets in the world. In the commercial aviation sector, India remains one of the highest traffic growth markets. It is estimated to become the third-largest aviation market in the world by 2025, and will likely need nearly 1,500 new commercial aircraft by 2030. Manufacturing for the aerospace sector is a complex exercise because it is capital-intensive, has high technological requirements, a complex supply chain and a prolonged gestation period. The impressive growth of the Indian Space Research Organization (ISRO) had added another set of opportunities for India and Indian industry. With an array of launch vehicles and satellite-building capability, ISRO has been seen as a jewel in the Indian scientific community. The value of the global space industry in 2025 is estimated to be over \$550 billion and India's market share is seen as just 2%<sup>7</sup>.

New Space entrepreneurship - a disruptive dynamic based on using end-to-end efficiency concepts - has emerged in India with about two dozen start-ups who are not enamoured of the traditional vendor/supplier model but see value in exploring end-to-end services in the Business-to-Business and Business-to-Consumer segments.

<sup>7</sup> <https://www.thehindu.com/opinion/lead/expanding-indias-share-in-global-space-economy/article28286469.ece>

These start-ups discern a synergy with Government's flagship programmes like Digital India, Start-Up India, Skill India and schemes like Smart Cities Mission. Aerospace R&D, focussed on the future plans of DRDO for Advanced Medium Combat Aircraft<sup>8</sup>, Unmanned Combat Aerial Vehicle<sup>9</sup>; National Civilian Aircraft and a futuristic space programme are opportunities that are available.

With such significant opportunities, there are challenges that need to be addressed. These are access to technology and talent; and, building scale in a business that is extremely capital-intensive.

*Can close collaboration between the IITs and Industry could make this a \$100 billion industry by 2025?*

8 <http://delhidefencereview.com/2019/11/12/indias-advanced-medium-combat-aircraft-programme-gathers-steam-with-new-developments/>

9 <https://defenceupdate.in/aura-ucav-the-future-of-indian-airforce/>





Globally, Aerospace is a \$ 900 billion industry. India is the third largest market for civilian aircraft and therefore it is very important that the Indian Aerospace industry has to be a thriving one that can attract and retain engineering talent. The Aerospace Panel was a high-powered one, moderated by Dr. K. Radhakrishnan, the former Chairman of ISRO and currently (among other positions) the Chairman, Board of Governors of IIT Kanpur.



The other members of the panel were:

- (a) Padma Shri Dr. Kota Harinarayana
- (b) Dr. Bala Bharadvaj, Managing Director, Boeing India Engineering & Technology Centre
- (c) Mr. Ajit Prabhu, Chairman & CEO, Quest-Global
- (d) Prof. Sanjay Mittal, Department of Aerospace Engineering, IIT Kanpur

Given below are key observations from the panel discussions as noted by the Panel Rapporteur, Prof. Gopalakrishnan, Department of Aerospace Engineering, Indian Institute of Science.

Dr. Radhakrishnan began the session by suggesting that while aerospace covered a very wide area, we should focus on aeronautics and projects that are national priorities. He mentioned that over the past three decades a strong base of capability has been created around India's Light Combat Aircraft, Tejas. Looking forward, there are three areas of strong national interest and this includes the Advanced Medium Combat Aircraft (AMCA), Unmanned Aerial Vehicle / Aircraft (UAA or UAV), and, the Regional Transport Aircraft (RTA).

Given that India is the third largest market for civilian aircraft, MRO is clearly an opportunity for growth. To stay ahead in the race, India needs to be able to do better technology forecasting so that our platforms are state-of-the-art and there is no lag between technology and user expectations; we also need a strong backbone of industry in the mix.

### **Dr. Kota Harinarayana**

1. The development, building, certification and induction of aircraft is not possible without the setting up of an ecosystem that includes the IITs, industry and research labs. In fact, the IITs and IISc., have played a big role in the development of the LCA - out of 400 individual projects given out to the IITs / IISc., 398 were successful; nearly 300 industries and 40 R&D Labs were nurtured during the development of the LCA. As a result of such initiatives, several companies have developed leadership in many technology domains, and some of them have become exporters of high technology products.

2. The LCA was designed for India . It was not a platform that was designed for use in other countries and then made available to India. This development made us self-sufficient in technologies like servo actuators, on-board computing, etc.



3. The importance of a value system and culture for success in this complex undertaking would include the following :

- a. A clear vision that is articulated and understood by everyone
- b. A detailed strategy that is well thought-through and understood by all the organisations involved.
- c. Team excellence must be emphasised within the organisation, where collective glory is more important than individual excellence.
- d. The whole ecosystem must work together seamlessly right from the beginning, including educational Institutes, industry and the research labs This means that systems and processes must be followed properly.
- e. Constant upgradation of skills and technology as technological obsolescence is very high in several relevant technology areas.
- f. Looking forward, we need the IITs and IISc. to develop competence in Artificial Intelligence and Cognitive Sciences for next generation products; stealth technologies; use of artificial intelligence for system health monitoring and management.

### **Dr. Bala Bharadvaj**

1. Aerospace is not a single science but an industry with severe demands. The industry requires well-rounded people in with knowledge of several domains, one of the most important of these being psychology (to understand human-machine interaction).

2. The consortium model is the most important mechanism for this industry.

3. Many technologies are required for Aerospace. Technology is an enabler that will be used to solve specific problems. It is just as important to understand how technologies are used to create impact. Avoid “keyboard monkeys”.





### Mr. Ajit Prabhu

1. He highlighted the disparity between the aerospace and IT industry and described what constitutes a “brain drain” from other disciplines to IT.
2. The ecosystem has to be developed to be able to solve the various issues that the industry has to address. India now has the capability to build full subsystems locally.
3. Given the size of India's Aerospace market, there will probably be the need for investment of up to \$1 trillion in transport aircraft over the next two decades.

Therefore, the country needs to invest in building aircraft locally which means there are two choices:

- a. To build transport aircraft (such as RTA) from scratch here in India
- b. To attract global OEMs to set up shop to do precision engineering work and manufacture here.

### Prof. Sanjay Mittal

1. Several IITs have Aerospace departments with very good students and faculty.
2. Critical Technologies such as materials and understanding of manufacturing are important for Aerospace
3. Of the students who graduate both at the undergraduate and postgraduate level, very few remain in the Aerospace field. Several students choose to move into other industries such as IT.

To address these issues, suggestions are as follows:

- a. It is important to catch the students young and instill in them a sense of excitement in working in their area of training. For example, after the second year of the program, internships in DRDO, VSSC Trivandrum, etc., would help students understand the exciting work they could do, should they remain in aerospace.
- b. IIT faculty must be shared across the IIT system and offer courses which are accessible to students across all the IITs. This way, the expertise that is available in the many different areas of aerospace can be made available to students, wherever they might be.



- c. It is important to teach students new technologies such as composites and new alloys as well as configuration design
- d. Faculty need experience in industry to enable them to bring to life the topics taught.
- e. Test facilities for the new technologies need urgent upgradation. This is required, not just for design and development, but also to gain perspective by experiencing and understanding users directly.

#### Panel Recommendations:

##### 1. Strategic investments:

- a. An investment of around Rs.7000-10,000 crores is required for shared infrastructure that addresses technology development, integration and skills, with a long term perspective in mind.
- b. A state-of-the-art testing facility is also required.

**2. Technology recommendation:** Undertake development of an all-electric aircraft. It will help India take the lead in technology development and design. Focusing on this in mission mode will enable India to develop and build leadership in several new technologies in diverse areas.

##### 3. For the IITs :

- a. Create well-rounded students who can work well in cross-disciplinary teams and instill in them the passion to work in Aerospace Engineering
- b. Curricula that focus on building strong foundational knowledge in relevant technology areas and in humanities
- c. Sharing of infrastructure and faculty across the IITs
- d. Internships for faculty and students in Industry /ISRO/ ADA etc.
- e. On-going mentorship / inputs from eminent industry leaders to inspire and provide practical knowledge

##### 4. Ecosystem:

- a. Constant interaction between industry, academia, research labs and government agencies
- b. Willingness to invest in infrastructure and skills for the long term
- c. How can the IT industry roadmap be replicated for Aerospace engineering as well?



# THEME FOR THE **MANUFACTURING** SESSION

*The best Way to Predict the Future is to Create it.*

*- Peter Drucker*

India is an attractive hub for foreign investments in the manufacturing sector. Several mobile phone, luxury and automobile brands, among others, have set up or are looking to establish their manufacturing bases in the country. The manufacturing sector of India has the potential to reach US\$ 1 trillion by 2025. The implementation of the Goods and Services Tax (GST) has made India a common market which will be a big draw for investors.

An impetus on developing industrial corridors and smart cities would assist in integrating, monitoring and developing a conducive environment for the industrial development and will promote advance practices in manufacturing. Under the Make in India initiative, the Government of India aims to increase the share of the manufacturing sector to the gross domestic product (GDP) to 25% by 2022, from 16% and to create 100 million new jobs by 2022.

*The question becomes : How can the IITs help industry in achieving the \$ 1 trillion target in manufacturing by 2025?*



The Manufacturing Session had a panel that has a vast experience in the skill and science of manufacturing and this has given them deep insights as to the current status of manufacturing in India and what we collectively can do to bring up the overall productivity and make manufacturing more glamorous than it is today.



The members of the panel were:

- (a) Prof. Sarit Kumar Das Director and Professor IIT Ropar
- (b) Prof. P. V. M. Rao, the Mehra Chair Professor of Mechanical Engineering at IIT Delhi
- (c) Prof. Surjya Kant Pal, Professor-in-Charge of the Centre of Excellence in Advanced Manufacturing Technology at IIT Kharagpur
- (d) Mr. Bhaskar Bhat, former CEO Titan Industries
- (e) Mr. BVR Subbu, former President Hyundai Motor India

The session was ably moderated by Mr. S. Muralidharan, President Lucas Indian Services and Mr. Siddharth Das was the Session Rapporteur.

The panel started by outlining the status of manufacturing in India.

## Manufacturing sector in India

To accelerate the economic growth of India, one of the pillars to be focused on is the “MSMEs”. MSMEs have been recognized as the “Engines of Economic Growth” of India. MSMEs constitute over 90% of the total enterprises in most of the economies and are credited with generating the highest rates of employment growth and account for a major share of industrial production and exports.

### Challenges ahead of the MSMEs growth

1. Low adaptability of new technology and innovation hampering growth,
2. Inadequate credit assistance
3. Lack of guidance in research and innovation
4. Ineffective marketing strategies resulting in considerably low outreach to new markets
5. Usage of traditional machines and inadequate access to quality raw materials resulting in subpar quality of export products

## HOW IITs CAN HELP

The IITs are one of the major enablers for driving innovation in the country leading to economic growth. However, most of the innovations developed in IITs, remain only in the fundamental level. In contrast to this, the industries operate at different level than the IITs, and hence they never converge. Consequently, innovations are not getting commercialized because of the gap between the IITs and the industries. In order to bridge this gap, the concept of “Catapult” is essential for India which aims at the following:

- Access to world-leading technology & expertise
- Reach into the knowledge base for world-class science
- Capability to undertake collaborative and contract R&D projects
- Create a critical mass of activity
- Skills development at all levels



## The IIT - Catapult combination:

IITs are known for their strength, which comprise of several Centres of Excellences catering different technological innovations, experts in various research areas, sophisticated laboratories with focused research outcomes, large pool of bright and talented young minds, and a rich alumni base for connecting industry and academia. Thus, a Catapult Centre alongside an IIT would be the most suitable.

Some other perspectives were brought into focus.

1. A manufacturing sector job has not been in the consideration set of IIT graduates for the best part of the last 25 years. A significant portion of the blame for that has to be laid at the door of the sector itself, because it still tends to skew rewards in favour of financial capital and generally does not give intellectual capital its due. This situation is unlikely to change much with manufacturing remaining relatively capital intensive, and India remaining relatively capital scarce. The IITs contribution to the manufacturing sector, may therefore have to be in ways other than providing a constant supply of employable young engineers.
2. The IITs can enhance the 'capability' of the manufacturing sector by each IIT first specializing in a specific industry as a 'core focus' area.  
They could then create, in collaboration with industry, and with the active involvement of alumni:
  - a) Online courses for students in Tier 4 and Tier 5 engineering colleges on those areas that are most relevant to ensuring some semblance of industry- readiness among such students (Look at NTTF courses for Tool Design open to graduate engineers, as a good example).
  - b) Annual upgrading courses for faculty of Tier 4 and Tier 5 colleges, after ensuring a basic curricula and specific teaching infrastructure is put in place by those institutions (Something like a Summer School).
  - c) Quarterly courses for Best Practices & Emerging Technologies, Project Management etc for manufacturing sector executives, with fees structured in such a manner that large companies pay more than medium companies and so on.





- 3. Ensure that IITs contribute to truly building India’s engineering capability by giving ‘engineering services/design’, AI jobs, etc., the first week during placement season, and relegating ERP and, say, relatively lesser skill coding type jobs to the last week.
- 4. Get visiting faculty from Manufacturing industry – start with alumni – to teach courses or add to courses. Bring in young entrepreneurs to teach in areas like additive manufacturing or robotics, and rekindle the passion for engineering.

The panel finally identified challenges and came up with possible solutions and specific action items:

Challenge	What can IITs Do?	Specific Action Items
There is a lack of industry ready manufacturing personnel, manufacturing professionals and manufacturing leaders in the country.	<ul style="list-style-type: none"><li>• Revamping curricula to bridge existing gap between theory and practice.</li><li>• Strong connectivity with industries in design and delivery of curricula.</li><li>• Realizing manufacturing as an inter-disciplinary subject.</li></ul>	<ul style="list-style-type: none"><li>• Joint Industry Institute workshops to arrive at new curricula and delivery mechanisms.</li><li>• Creating fixed term and long term positions of “professor of practice” in IITs for senior industry professionals.</li></ul>
Present manufacturing practices are not globally competitive.	<ul style="list-style-type: none"><li>• Incentivizing faculty to indulge in “knowledge application” and not just “knowledge creation”(research) activities.</li><li>• Identify technology gaps to be globally competitive and initiating new R&amp;D efforts.</li></ul>	<ul style="list-style-type: none"><li>• Metrics to recognize efforts made by faculty towards knowledge application.</li><li>• Special emphasis on manufacturing metrology and measurements.</li><li>• Research initiatives and faster adoption of Industry 4.0</li></ul>
There are more “job seekers” than “job creators” in the space of manufacturing.	<ul style="list-style-type: none"><li>• Special emphasis and promotion of stratups in the space of manufacturing.</li></ul>	<ul style="list-style-type: none"><li>• Deep tech incubator in IITs the domain of manufacturing.</li><li>• Creation of pre-incubation fellowships for graduating students.</li></ul>
Prevailing climate for Industry-Institute interactions are weak.	<ul style="list-style-type: none"><li>• Promoting industry-interactions by design.</li></ul>	<ul style="list-style-type: none"><li>• Faculty externships in industry</li><li>• Creation of research parks and catapults (along the lines of UK universities).</li><li>• Industry sponsored chair professorships at IITs</li></ul>
Value addition in manufactured products by SMEs is not significant.	<ul style="list-style-type: none"><li>• Need to strengthen design education in IITs.</li><li>• Manufacturing and testing support to SMEs.</li><li>•</li></ul>	<ul style="list-style-type: none"><li>• Starting product design and DFM courses and programs at IITs.</li><li>• Improved access to technology and infrastructure at IITs to SMEs</li></ul>
Lack of stronger and stable policies in manufacturing.	<ul style="list-style-type: none"><li>• Starting public policy schools and departments in IITs</li></ul>	<ul style="list-style-type: none"><li>• Manufacturing policy vertical in public policy schools and departments.</li></ul>
Huge gap between production and consumption manufactured products in some areas.	<ul style="list-style-type: none"><li>• Identify and initiating special programs to fill this gap</li></ul>	<ul style="list-style-type: none"><li>• Initiating special programs in design and manufacturing of products such as medical devices, technical textiles, machine tools.</li></ul>



# WAY FORWARD

## AND KEY RECOMMENDATIONS

The house, led by Mr. Kris Gopalakrishnan, Chairman Axilor Ventures, discussed and came up with a high-level Strategic Action Plan addressing specific sector programmes, best practices in the IITs and participation of industry in collaboration with the IITs in technology development.



One set of programmes will be very specific and are important for our country and around this we need to pull in lot of other resources that are required to make this happen and because these are specific, public or private industry may be interested. It would be appropriate to house these resources in IITACB and also figure out what other resources are required we need to do that task.

**Actions are :**

- (a) We should define this,
  - (b) we should identify the resources and let the resources come up with a high level plan in the next two months, and,
  - (c) we should have sub-committees of IITs, industry which are going to participate and decide on how to take this forward.
- The ICT panel have come up with Artificial Intelligence and 5G networks as specific projects. During the discussion, they have also identified resource persons, Dr. Vivek Raghavan, and Mr. Arnob Roy for the two areas respectively, who will come up with specific projects and they need to identify which IIT would work on this and which industry we can reach out to and partner.
  - In Aerospace, specific projects were (a) Unmanned combat aircraft, (b) Regional Transport Aircraft, (c) Advanced Medium Combat Aircraft. It would be difficult to take up all three but we can certainly look at common technologies that could be used across multiple platforms and create a slew of projects with the IITs.
  - In Biotech as well, the belief was that we could come up with couple of programmes which will be interesting and for Manufacturing, probably one of the industry can take this up.

The second set are Best Practices which people have experimented with in some of the IITs. Examples include Professors of Practice, Faculty Sabbaticals / Externments, Paid Internship, Centres of Excellence with industry collaboration.





The suggestion was to detail this out, and make sure that this information goes to all the IITs and maybe to all the other institutions that are interested in taking this forward. Suggestion: Can best practices be built into the criterion for NIRF rankings?

The third set is interactions with the industry. People talk about some Centres of Excellence, like the Bosch Centre that have been established. There is a need to encourage a lot more participation from industry.

We should create an environment where industry can take a leap of faith and trust our academic institutions, not necessarily as individual companies but maybe as a consortium. This is something that IITACB should take forward.

We definitely need to bring industry money to IITs and we should start with trying to look for 10 programmes and build a consortium from industry for specific institutes to work with.

Therefore, the key projects going forward would be :

1. Building a Centre of Excellence in Artificial Intelligence anchored by Dr. Vivek Raghavan inside IITACB.
2. Co-ordinating a group from Industry and the IITs and working on 5G networks.
3. Co-ordinating a Biotech group from industry and the IITs that will use AI platforms to curate and host genome data sets.
4. Co-ordinating a committee that will identify projects inside DRDO / ISRO etc., that can be made into modules and shared as mission-driven projects with the IITs and with industry collaboration.



5. Building a suite of industry best practices in Manufacturing and taking them to multiple industries and IITs.
6. Look for ten large-scale Industry /IIT collaborative projects that would be co-funded by industry and the government.

All the planning on these efforts will be executed within the next 3-6 months.

At the time of this writing (April 8, 2020) the Covid-19 situation highlights the need for the IIT and Industry to work closely together. In hindsight , the themes chosen for the Conclave were very relevant - for example, in Biotechnology, IITACB should be able to co-ordinate the efforts of all the IITs along with those of industry and we should be able to come up with a white paper on how best to address this in the long term so that our country is not vulnerable to the extent it is possible to prevent catastrophes.

Moreover, this brings out relevance to the Government of India's Make in India and Skill India programmes which would benefit from the knowledge base in the IITs.



Machine Learning (ML) and Artificial Intelligence (AI) are not yet fully developed tools or products in spite of their numerous successful applications. According to Michael Jordan, AI is a wonderful aspiration that we don't yet have. Not even close. But the area where Statistics meets Computer Science is likely to be more exciting for many years to come. ML has come of age. But it is far from being a solid engineering discipline that can yield robust, scalable solutions to modern data analytic problems. There are many hard problems involving uncertainty, inference, decision-making, robustness and scale that are far from being solved not to mention economic, social and legal issues. The IITs and IISc are well poised to work with the industry to make the human aspiration a reality sooner.

Let us see how ML had grown over the last few decades.

**First Generation ('90-'00): the backend**

- e.g., fraud detection, search, supply-chain management

**Second Generation ('00-'10): the human side**

- e.g., recommendation systems, commerce, social media

**Third Generation ('10-now): end-to-end**

- e.g., speech recognition, computer vision, translation

**Fourth Generation (emerging): markets**

- not just one agent making a decision or sequence of decisions - but a huge interconnected web of data, agents, decisions - many new challenges!

There are three perspectives of AI:

1. The classical "human-initiative" perspective - cf. AI in the movies, interactive home robotics.
5. The "intelligence augmentation" (IA) perspective - cf. search engines, recommendation systems, natural language translation- Good enough Translation; - the system need not be intelligent itself, but it reveals patterns that humans can make use of.
6. The "intelligent infrastructure" (II) perspective- cf. with IoT transportation, intelligent dwellings, urban planning - large-scale, distributed collections of data flows and loosely coupled decisions.





Problems studied from the "human-initiative" perspective aren't necessarily the same as those that arise in the IA or II perspectives.

Unfortunately, the "AI solutions" being deployed for the latter are often those developed in service of the former. To make an overall system behave intelligently, it is neither necessary or sufficient to make each component of the system be intelligent. "Autonomy" shouldn't be our main goal; rather our goal should be the development of small pieces of intelligence that work well with each other and with humans.

Let us look at some Statistics and CS Challenges

### Robustness

We these days are using very large, uncurated datasets to fit very large models. Ideally we would like our models + training procedures to not be brittle. There are lots of surprising security + privacy issues when training and deploying models, and lots of people like to think about these. Robustness in the face of adversaries.

Dealing with data-scarcity - often big deep neural networks require lots of data to train. So people have come up with different ideas:

1. Pre-train a model on a large data set, and then re-train/adjust the model using smaller amounts of when applying it.
2. General unsupervised, semi-supervised, active learning -- we still don't know how to do these well.

3. Self-supervised learning - something that works much better in practice is to pre-train the model to predict unsupervised data, by masking parts of it

(<https://towardsdatascience.com/self-supervised-learning-78bdd989c88b>)

Dealing with things like distribution shifts - we usually think of training a model on some data, deploying it and expecting it to perform well at test time. Things often drift - i.e. test populations can be very different from training populations and we'd like to be able to detect this and "fix" our models.



### Causal Inference

We often think of ML as synonymous with prediction (classification/regression) tasks. People now have started to think more about interventions, and counterfactuals -- which is more similar to attempting to reason about cause and effect (which maybe is closer to AI).

<https://cacm.acm.org/magazines/2019/3/234929-the-seven-tools-of-causal-inference-with-reflections-on-machine-learning/abstract>

### Reinforcement Learning

Similar to above lot of recent success in things like chess+Go - AlphaZero. People are getting stuck in terms of progress in more open and tasks like self-driving cars.

### Fairness/interpretability

Big models are difficult to interpret + just blindly optimizing some training loss might result in huge disparities in predictions.

### This article

<https://www.propublica.org/article/machine-bias-risk-assessments-in-criminal-sentencing> is great and kicked off research in this field.



1. There is a major 5G testbed project funded by DoT – several IITs (IITH, IITM, IITD, IITK, IITB, ...) and IISc are involved in it.
2. WiSiG a company incubated at IITH by Prof. Kiran Kuchi has the world's biggest 5G Massive MIMO (multi input multi output) prototype. WiSiG is also fabricating NBIoT chip – the first of its kind. The first version should be out in the last quarter of 2020-2021.
3. IITH and WiSiG have good collaboration with Tejas
4. Indian Industries and industries in general do not come forward to support high risk research. Industries typically support turnkey projects. They rarely support high risk projects. Moreover, there are hardly any industries in cutting edge ICT areas. Thus, IITs and IIScs are left with no option but to look for MNCs for support towards high risk projects.
5. Govt. of India has three major initiatives in future ICT areas: ICPS (interdisciplinary Cyber Physical Systems) – Rs. 3,600 crores, (ii) Quantum Computing and Communication – Rs.8000 crores, and AI – it is in the pipe line and could be a mission with Rs.5000 crores or more.
6. ICPS: 25 hubs will be set up at leading academic institution; each hub will have a unique focus area-like – AI and ML, Robotics and Automation, IoT, AR/VR, Video, Speech and Text analytics, Unmanned Vehicles (aerial and terrestrial), etc.
7. (There is a strange dichotomy – we take support from MNCs – but – we compete with them at 3GPP – world telecom standardization body).
8. India has a great opportunity to make significant contribution in AI for Edge Devices. Edge devices are those devices are the ones like mobile phones, tablets, laptops, etc.. Basically, Edge devices are those which have limited computing, memory and battery resources.
9. India need not invest in a Foundry. Fabless Chip Design can be made a mission area in India. IITH already has a Fabless Chip Design Incubator with 6 companies (two of these companies are operating from Bangalore and one from Chennai).





## LIST OF DIRECTORS

1. Prof. V. Ramgopal Rao, Director IIT Delhi
2. Prof. Abhay Karandikar, Director IIT Kanpur
3. Prof. V.K. Tewari, Director IIT Kharagpur
4. Prof. Subashis Chaudhuri, Director IIT Bombay
5. Prof. T.G. Sitharam, Director IIT Guwahati
6. Prof. Sudhir Jain, Director IIT Gandhinagar
7. Prof. Timothy Gonsalves, Director IIT Mandi
8. Prof. Sarit Kumar Das, IIT Ropar

## LIST OF PANELISTS

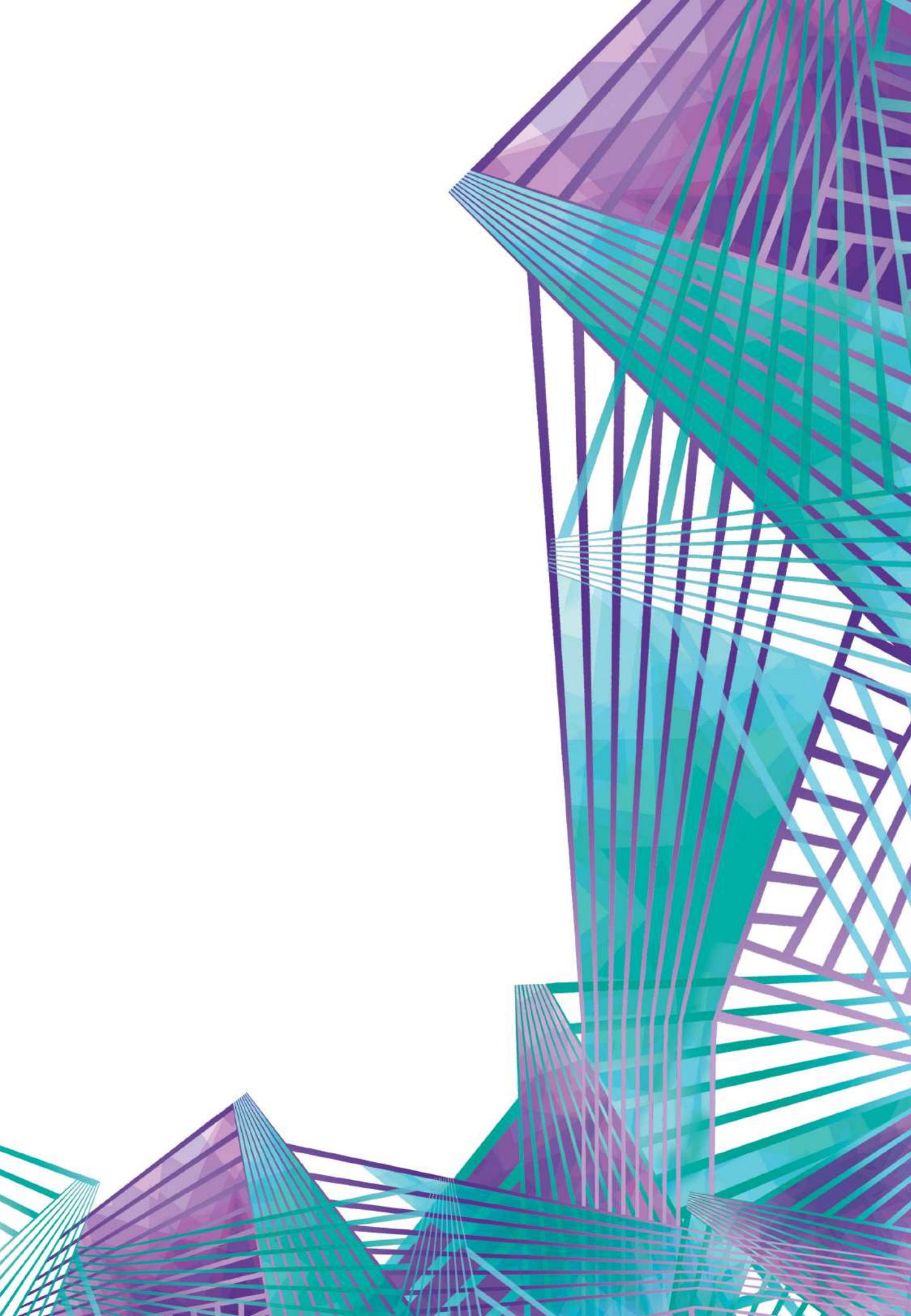
1. Mr. Ajay Bharadwaj, Founder and CEO Anthem Biosciences,  
Bengaluru-Panel Moderator
2. Dr. Syed Kazmi, President, Jubilant Therapeutics Inc., USA
3. Dr. Suresh Madhavan, Chairman and CEO, PointCross Life Sciences, USA
4. Dr. Vijay Chandru, Founder, Strand Life Sciences, Bengaluru
5. Prof. P.Balaram, former Director, Indian Institute of Science
6. Prof. Satyajit Mayor, Director, National Centre for Biological  
Studies, Bengaluru
7. Dr. Dhanajaya Dendukuri, Founder Achira Labs (Rapporteur)
8. Mr. Samir Kumar, Managing Director Inventus India - Panel Moderator



## LIST OF PANELISTS

9. Prof. Uday Desai, former Director IIT Hyderabad
10. Prof. V. K. Tewari, Director, IIT Kharagpur
11. Prof. N. Balki Balakrishnan, IISc. Bengaluru
12. Mr. N. Krishna Kumar, former Chairman Mindtree Technologies  
and NASSCOM
13. Mr. Arnob Roy, Founder and COO, Tejas Networks, Bengaluru
14. Mr. Anand Talwai, Member Governing Council IITACB (Rapporteur)
15. Dr. K. Radhakrishnan, former Chairman ISRO - Panel Moderator
16. Dr. Kota Harinarayana, Father of Tejas
17. Dr. Bala Bharadvaj, Managing Director, Boeing ETC Bengaluru
18. Mr. Ajit Prabhu, Founder and Chairman Quest Global, Singapore
19. Prof. Sanjay Mittal, IIT Kanpur
20. Prof. Gopalakrishnan, IISc. Bengaluru (Rapporteur)
21. Mr. S. Muralidharan, President Lucas Indian Services, Chennai - Panel  
Moderator
22. Mr. Bhaskar Bhat, former CEO, Titan Industries
23. Mr. BVR Subbu, former President, Hyundai Motors India
24. Prof. PVM Rao, IIT Delhi
25. Prof. S. K. Pal, IIT Kharagpur
26. Prof. S. K. Das, IIT Ropar
27. Mr. Siddarth Das, Venture East (Rapporteur)









ALUMNI CENTRE  
BENGALURU

56, Sai Maruthi, 13th Cross,  
Malleswaram, Bengaluru 560 003

[iitacb.org](http://iitacb.org) | [info@iitacb.org](mailto:info@iitacb.org)