Teachers' Day Lecture 2023

Speaker

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Education, Research, Innovation in the Brave New World: From Invention to Innovation

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This talk is NOT about a specific area or product of science, but an examination of some of the compelling **_processes_** of doing science and its **_translation_** to useful applications. Such *processes* include, but are not limited to: the power of lateral thinking and scientific commonsense; connecting the dots, creativity, being interdisciplinary; relating a narrow domain of research to the larger concerns of science and, while doing all this, putting some fun, quality and excitement back in research starting at PhD level! In short, everything not addressed in classrooms or even in labs!

The talk will indicate some major oncoming challenges, opportunities and directions in scientific research such as: Sustainable Development, Convergence of technologies, Rise of Intelligent Machines & Industry 4.0/Society 5.0, Managing Data and information and knowledge: Science Communication and Popularization; Connecting Science to Innovation and Society; and Nurturing Diversity. To meet these and other challenges, some concepts such as these are useful: Invention vs innovation; knowledge pyramid and circle; Tool centric vs Problem centric science; Connecting to Startups, Industry; Research with relevance and direction; Incremental vs profound research; Reward and recognition structures in academia, R&D; Balance of *Juggad, Dhandha, Panga*; and Scientific Social Responsibility.

Of invention and innovation

While it is generally not well understood, invention and innovation are totally opposite processes in that inventions create new knowledge, whereas innovations transform that

knowledge into new socio-economic opportunities. Thus, interestingly the architecture, structures and processes of invention and innovation are nearly orthogonal to each other! It is vital that invention and innovation ecosystems work together seamlessly to create and sustain a knowledge society and economy. The sustainability of knowledge requires that the inventions create and transmit knowledge and innovations consume that knowledge to create new socio-economic opportunities. A holistic society that is strong both in knowledge and economy requires that Goddess Laxmi and Goddess Saraswati not only have empathy, but also work proactively work together for their own good!

As regards the state of invention/discovery ecosystem in India, her ranking in publications, R&D & innovations has risen rather steeply in the past decade. India is now placed 3rd globally in the number of scientific publications as per an NSF database. It has also reached **3rd** Position in term of no of PhDs, in size of Higher Education System. Although our science and technology knowledge producing systems such as IITs, IISERs, Research Labs and Universities have deep strengths, the weakness often has been in the quality, relevance and direction of the knowledge produced and its lack of strong connect with knowledge consumption led by industry and other societal stakeholders. An unprecedented rise of technology led startup movement within a decade has provided a compelling link to joining of invention and innovation ecosystems at its back and front!

As regards the state of innovation in the country, it has 3rd largest number of startups. The country now is featured within the top 50 innovative economies globally owing to the rapid strides in the past five years, as per Global Innovation Index (GII). Starting 2016, the Union Department of Science and Technology (DST), initiated a major directional shift in the startup ecosystem by enhancing funding nearly 5 times and by launching a new scheme called *"National Initiative for Developing and Harnessing Innovations (NIDHI)"*. The key idea was to strengthen each vital link of the innovation chain since the strength of a chain is only as good as the strength of its weakest link! NIDHI addresses the needs of scouting, mentoring, networking and training of innovators; prototyping support; business plans; sustaining factors such as fellowships and timely seed funding; and transition to manufacturing and market together with creation of network of technology business incubators. NIDHI has thus nearly doubled the number of DST created incubators in the last five years with emphasis on quality and empowerment. A recent third party assessment of DST incubators alone showed that nurturing of 3,681 startups through a network of around 150 incubators generated 65,864 jobs as direct employment, created new wealth of Rs 27,262 crores and produced 1,992 intellectual property during the last 5 years. The collective strength and power of NIDHI was tested

successfully during the current pandemic through the "*Centre for Augmenting WAR with COVID-19 Health Crisis* (CAWACH)" program which supported over 70 startups with speed and scale to produce an array of relevant solutions in PPEs, N95-99 masks, ventilators, diagnostics, disinfectants, etc.

Innovation is also a pyramid with culture of innovation and policies at its base. To address this, DST initiated in 2017 a scheme called *"Million Minds Augmenting National Aspirations and Knowledge (MANAK)"*, under which 10 lakh innovative ideas are annually targeted online in any of the Indian languages from more than 5 lakh middle and high schools across the country. Up to one lakh top ideas are shortlisted for an award of Rs. 10000 each for the preparation of a prototype and participation in the District Level, state level (10000 prototypes) and national level exhibitions (top 1000 prototypes). This program has seeded the power of independent innovative ideas in our young minds who will be the innovators and entrepreneurs of tomorrow in numbers.

DST has also co-created and co-funded several large-scale innovative challenge programs in partnership with industry bodies and corporates. Some of the flagship programs that have generated tens of thousands of ideas, various support mechanisms and success stories from the young innovators include the Global Innovation Technology Alliance (GITA) in partnership with the Confederation of Indian Industries (CII), Power of Ideas with the Economic Times, the India Innovation Growth Program in partnership with Lockheed Martin and Tata Trusts and IMPRINT program co-funded by Departments of Education and Science and Technology for development of relevant products and technologies. Further, 3 newly created, professionally managed SATHI centres at investment of Rs. 475 crores are to address the key needs of startups for easy access to the high-end technology infrastructure and information for characterizing, testing, designing, standardizing and fabrication of products.

India has rapidly internalized the concepts and actions of innovation through a multidimensional national strategy starting from the launch of the Make in India and Start-up India Initiatives, and the hugely empowering roles of the Atal Innovation Mission (AIM) of the NITI Ayog and a plethora of sectoral incubators of MeitY, DBT and other ministries. This is reflected in an extraordinary rise of India to the top 50 innovative countries up from its 81st rank just a few years back in 2015! The positive march of startup culture, structures and processes will gain fresh momentum by institutionalizing the key message of COVID-19 times in the working together of industry, startups, academia and government with clear and present objectives and shared purpose and vision. The innovation ecosystem will continue to build on the foundational programs already initiated and gain substantial further impetus within the framework of a new

policy on Science, Technology and Innovation 2021 which is in its final stages of formulation.

In my talk I will also briefly discuss some of the major foundational aspects of innovation ecosystem: (1) Socio- psychological- cultural dimensions of innovation; (2) concept of *Aatmanirbharta* as facilitated by the triad of *Aatma-viswas*, *Samman*, *Chintan*; (3) Inclusive and grass-roots innovations; (4) Demography, diversity, equity and inclusion; (5) policy dimensions as basic enablers; (6) structure and processes of a seamless integration of invention and innovation ecosystems; (7) Overarching techno-societal challenges of the future and the new mind required to meet them; (8) the reality of education in India being out-of-sync (orthogonal) to innovation mindset comprising of learning, synthesis, independence in thought, risk taking, creativity, multi-tasking, problem-solving abilities, etc.; (9) the balance and deployment of the triad of *Dhandha* (business as usual) - *Juggad - Panga* (disruptive) for problem solving; (10) How and why innovations/startups fail?; (11) And finally the most important aspect of innovations - compelling roles of humanities and social sciences! I would say innovation is only about 50% of S&T!

I will illustrate the Policy Dimension with a recent example of the DST policy on Liberalization and Democratization of Surveying, Mapping and Geospatial Data which among other things is driving high resolution digital mapping of India at 10 cm resolution. The SVAMITVA Scheme launched by Hon'ble Prime Minister of India on National Panchayat Day (24th April 2020) will now allow digital land ownership certificates for rural India through drone and land-based surveys. This is an unprecedented instrument of rural empowerment allowing bank loans (rather than local moneylender loans!) and resolution of infinite litigations!

I will illustrate the concept of seamless integration of Invention and Innovation ecosystems by an example pf the DST's National Mission on Interdisciplinary Cyber Physical Systems (ICPS), which includes basic R&D to technology and human resource development to incubation and industry partnerships in the areas of Artificial Intelligence, Industry 4.0, Robotics, Sensors, IoT, etc. to meet the oncoming challenges. Currently, 25 Technology Innovation Hubs set up under NM-ICPS are bringing strong collaborations and co-ownerships among industry, start-ups, academia, and government, connecting all of them with full flexibility.

There has never been a better time to channel and leverage our demographic dividend, diversified markets, deep strengths in R&D, data and demand through innovation for an *Aatamnirbhar* Bharat. Succeed we must at scale with speed!