

Transformational Technologies and U.S.- India Science and Technology Cooperation

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The project

The Centre for Public Policy Research (CPPR) is conducting a 10-month long project on US - India Relations: Change, Continuity and Transformation. This project is supported by the US Consulate General, Chennai, Public Affairs Section, and aims to study the US - India partnership across four focus areas - i) US-India Partners in Global Climate Action, ii) Indo-Pacific Strategy: Reimagining the Maritime Outlook, iii) US-India Trade Relations: To the Next Level, and iv) US-India Science and Technology Cooperation. The project aims to prepare a platform for conducting informed discussions and sharing concrete and actionable policy recommendations for private and government functionaries from India and the United States on the focus areas.

To that effect, CPPR has conducted four webinars on the selected topics with the participation of subject matter experts from the two countries. The fourth and final webinar was hosted on March 24th, 2022, and was titled 'Transformational Technologies and U.S. - India Science and Technology Cooperation', addressing the Science & Technology focus area. The speakers for the webinar were Mr. Jay Gullish - Executive Director of Digital Policy at the U.S.-India Business Council (USIBC), and Dr. Nandini Kannan - Executive Director at the Indo-U.S. Science and Technology Forum (IUSSTF).

Jay Gullish is the executive director, digital policy at the U.S. - India Business Council. He has passionately promoted digital development in more than 20 countries over his 25 years of experience in government, industry, and civil society across the telecoms, information technology, satcom, and cyber sectors. Most recently, he served as a digital policy officer at the U.S. Embassy in New Delhi covering cyber policy, telecommunications, information technology, digital inclusion, and commercial space. While at the Embassy, he aligned U.S. cyber policy towards India across multiple in-country USG agencies and consulates. He was also the in-country lead for the U.S.-India ICT Working Group and the U.S.-India Cyber Consultations. Jay Gullish has previously worked in India's outsourcing industry, and lived and worked in India for over five years. He has international technology experience in southern Africa, Israel, and Vietnam.

Dr. Nandini Kannan is Executive Director of the Indo-U.S. Science and Technology Forum. She has leadership experience in academia and government, with an understanding of the critical role that science and technology play in this global interconnected society, and a deep commitment to education and workforce development. Since 2014, she has served as a Program Director at the US National Science Foundation (NSF) where her responsibilities included core disciplinary research, mathematical sciences research institutes, and workforce development programs in the Division of Mathematical Sciences as well as a number of cross-directorate and cross-agency activities. She has served as a co-chair for several Data Science related activities in support of Harnessing the Data Revolution, one of NSF's 10 Big Ideas. Dr. Kannan also helped to create partnerships with the National Institutes of Health (NIH) to support collaborative efforts in biomedical data science. She is a Fellow of the American Association for the Advancement of Science (AAAS), American Statistical Association (ASA) and an Elected Member of the International Statistical Institute.

The discussion was moderated by Varsha Radhakrishnan, Research Fellow, Technology Policy & A.I. at CPPR. Varsha leads Analytics & Growth initiatives for an e-commerce platform at IBM, where she leverages choice architecture to drive positive user experiences and growth in engagement, adoption, and retention. Prior to this, she was developing AI-informed solutions to address IBM's business challenges, using predictive technologies, robotic process automation, and recommendation engines. Her academic focus areas are in Economics and Public Policy. She is a Research Fellow with CPPR handling Technology Policy and Artificial Intelligence.

The discussions at the webinar were synthesised into this issue brief by Varsha Radhakrishnan, with assistance from Sharon Susan Koshy, Associate, Anu Anna Jo, Senior Associate, and Dr. Reetika Syal, Senior Office, Research at CPPR.

U.S. & India - Science & Technology

The U.S. and India partnership is founded on an alignment in democratic values, strategic goals, and economic interests. Science & Technology are critical and transformative aspects of this U.S. - India relationship that shapes and accelerates the strategic and economic achievements of both nations. Both countries have repeatedly proven their commitment to cutting edge research and the development of partnerships at several levels to promote technology-driven innovation in shared matters of national interest. The following are some examples of this commitment to a Indo-U.S. dialogue architecture for S&T:

- A government-level agreement between the two countries helped form the autonomous bilateral organisation, Indo-U.S. Science & Technology Forum (IUSSTF), in 2000
- Through the IUSSTF, the U.S. Department of State and India's Department of Science & Technology have jointly established the U.S.-India S&T Endowment Fund (USISTEF) that is responsible for creating opportunities and activities for collaborative R&D between government, academic, and commercial entities
- S&T Summits, Joint Commission meetings, and academia-industry conferences are responsible for shining a spotlight on this topic and for the forming of longer term partnerships
- Working partnerships between U.S. and Indian scientific researchers and organisations specialising in commercial technology
- Private sector-led technology initiatives such as the Microsoft cybersecurity skills campaign expansion to India through their partnership with the nonprofit ICT Academy and the CyberShikshaa program

A critical element of these facets of the dialog architecture is the more organic people-to-people network, movement, and ground-level interactions. It is a key enabler of a larger science & technology ecosystem and the investment flows that support it. As of 2019¹ 2.7 million people have migrated from India to the United States, developing a strong pool of talent and leadership in science and technology - 32 per cent of the top AI startups in the US were created by Indian-Americans² . U.S. tech executives in turn continue investing significantly in the Indian market; for example, since 2020, some of the biggest US tech companies have invested around \$17 Billion in India³ . The nature of academic and industry collaborations is also ultimately driven by people who may have first-hand understanding of some market and societal needs, can identify synergies in their work and thus co-create innovative solutions. The people-to-people engagement brings external economies of scale, emerging from the sharing of knowledge that helps other similar businesses to more easily enter the market, creating an ecosystem that benefits from higher competition and thus higher quality of

technological development. Importantly, the sharing of knowledge and expertise is paving the path for a new generation to be better equipped to tackle socio-economic challenges using technology.

Considering the various aspects of partnership that currently exist between India and the U.S. in the S&T realm, both countries are well placed to jointly chart the future growth of emerging technologies such as Responsible AI, quantum technologies, and big data (along with their governance), in addition to technologies that are critical to the future of geopolitics and livelihoods - such as space tech. While the continued development of these technologies is important, also critical are the innovative partnerships, workforce development, and the institutional mechanisms to support the translation of S&T developments into positive socio-economic outcomes.

History and context for the Indo-U.S. S&T Partnership

The two powerful democracies have experienced pivotal moments in the history of their partnership over the past several years that influenced the acceleration and trajectory of S&T development and the strength of the partnership itself. Scientific cooperation goes back all the way to the 1950s and 60s through India's Green Revolution (supported by the USAID) which focused on modern irrigation methods, chemical fertilisation, and high-yielding seed varieties - raising grain production from 70 million tons (1954) to 200 million tons 50 years later⁴. In 1959, IIT-Kanpur was established with the assistance of leading US research universities and further supported for 10 years by the Kanpur Indo-American Program (KIAP), which helped to establish research laboratories and computer science education. In 1975, the NASA-ISRO Satellite Instructional Television Experiment (SITE) made it possible for information television to reach rural areas, demonstrating the value of using satellite technology in education and to support financially-strapped and illiterate communities. At an institutional level, a key bilateral initiative was the establishment of the IUSSTF in 2000, which has since facilitated interactions at a large scale between Indian and U.S. scientists, supporting 15,000 scientific projects across 10+ sectors, around 337 bilateral workshops, and joint research centres. Another significant historical aspect that elevated the partnership is the stream of Indian tech talent moving to the United States for further studies and employment opportunities; 14%⁵ of the U.S.'s international students are from India, promoting the U.S.'s strategic ambitions in critical technology growth areas such as Artificial Intelligence. Additionally, 11% of the top 50 AI startup founders are Indian immigrants to the U.S., who create thousands of jobs in the American economy and also in the Indian markets through outsourcing and investments.

More recently, India became the first Asian country to send an operational mission to Mars (the Mangalyaan satellite) in 2013, with the help of NASA providing deep space navigation and support to ISRO. This expedition solidifies the Indo-U.S. civil space cooperation (where both countries emerged triumphant amidst low success rates for other countries in any Mars mission) for better communication and weather warning systems. Another pivotal moment in this partnership was a shared and time-sensitive concern around the Y2K challenge and the software industry. The U.S. government began addressing the problem, but needed a large workforce to help implement the solution. India's IT companies such as Infosys and TCS leveraged the opportunity by providing the largest pool of low-cost and highly-skilled engineers, and helped strengthen their base in Information Technology. Y2K created a significant boost to India's \$7.6 billion⁶ IT industry.

The two countries' significant interest in AI innovation has led to the movement of technology giants such as Microsoft, IBM, and Google establishing research centres and labs in India. While building expertise in new-age technologies and solving issues of society are the primary focus of such initiatives, it has also pushed both the IT industry and academia to think differently about research problems, adopt more interdisciplinary approaches, and re-imagine education and training.

Thus, our history of Science & Technology collaboration has been structurally influenced by larger milestone moments and also by the more organic, ongoing shifts in partnership behaviours that have rendered the S&T cooperation a critical function of the Indo-U.S. partnership.

Enablers and Barriers to the Indo-U.S. S&T Partnership

In any bilateral partnership, there are factors that enable or impede the outcomes of that partnership, such as resources, funding, investments, policies, and even conflicting global interests. For instance, India's pool of tech talent moving to the United States has, among other things, enabled the establishment of the top AI startups in the US, and U.S. tech executives continue investing billions in the Indian market to proactively enable innovation. Undoubtedly, there are also several obstacles to smooth partnership-informed innovation, such as the Intellectual Property Rights conflicts in the 1990s. This section will explore the various factors that are influential in both the catalysing and deterrence of partnership effectiveness.

Values, political relationship, and strategic interests:

As the two largest democracies with deeply shared interests around economic prosperity, clean energy, a stable Indo-Pacific region, and a commitment to democracy and government, an interdependence is established that creates the impetus for joint progress in the technology realm. Additionally, the regular high-level political visits that have continued to fuel bilateral cooperation are also sustaining the momentum in S&T development. Both countries' leaders need to continue paying attention to the long-term partnership and valuing the interdependence so as to reach full potential in technological progress.

Infrastructure, regulations, and bureaucracy:

From the perspective of U.S. market entry into India, there are several challenges. India imposes high tariffs on U.S. exports and has had a stringent regulatory landscape with global payments companies being required to store data locally, digital taxes on global internet platforms, and rules to regulate global messaging. However, India is not alone in its intentions to promote homegrown efforts and alternatives. The differences in government and bureaucratic structures can create barriers to efficient S&T cooperation at the ground-level. As the world's largest democracies go digital, it will become even more important for both countries to arrive at agreements that would prevent the attrition of Science and Technology collaboration.

Small-Medium Enterprise (SME) partnership challenges:

SMEs are some of the most agile innovators in both countries. While large-scale collaboration is highly organised across both countries at the government, corporation, and academia layers, there has not been a similar level of organisation and creation of mechanisms to promote partnerships among smaller innovators and incubators. Lack of awareness is said to be a key barrier in this. Thus, helping small business across both countries understand the opportunities that exist in their counterparts, identifying good partnership fit, and guidelines for successful navigation of the business landscapes in both India and the U.S would help significantly.

Funding:

Funding is critical for supporting joint activities that give rise to promising innovation and entrepreneurial initiatives. For instance, within the framework of the U.S.-India S&T Endowment Fund, over 10 years of grants and projects with a marketable prototype have been given funding, along with other similar programs. However, this has not been sufficient. U.S. universities, for instance, have benefited from significant endowments that have helped sustain long-term research. This is not the case with Indian universities, and government R&D funding is at 0.7%⁷ of GDP, which is lower than most other countries. It should also be noted that government-funded research is not the only catalyst for technological progress, as a significant amount of innovation arises from private investment. Funding must be outcome-focused and not approach-focused so as to ensure the best allocation of resources while allowing creative autonomy for industry and scientists alike.

Public events and conferences as enablers:

Conferences, working groups, and collaboration forums such as US-India Artificial Intelligence (USIAI) Initiative, Indo-US Working Group on ICT, etc are enablers of dialogues and synergies across scientists, researchers, industry leaders, and incubators. This continued shining the spotlight on S&T also helps educate people about the India and U.S. markets, offering opportunities for a cultural and intellectual exchange of ideas. Given the rapid integration of new technologies across a wide range of sectors, it will be important to continue enabling and publicising events, workshops, and trainings that assemble representatives across different disciplines and vocations to enable interdisciplinary dialogue that can lead to the identification of smarter and more relevant S&T solutions.

What Emerging Technologies and Skills do we need to prioritise?

Aided by a largely fruitful partnership history and continued efforts to maintain the partnership despite the challenges, both the U.S. and India are well positioned to forge ahead in newer territories by leveraging and governing emerging technologies to address joint priorities in healthcare, smart cities, education, and financial technologies. Doing so will help both countries achieve their strategic, economic, and global influence goals. Some examples of existing partnerships in the emerging technologies space are:

- At a government-to-government level, U.S. Trade & Development Agency is a key cooperator of India's Ministry of Housing and Urban Affairs in the planning and development of smart cities. In Ajmer, Allahabad, and Visakhapatnam this partnership has brought in innovative growth, using advanced data governance, an open data platform, and digital infrastructure for public goods. The U.S. also benefits from this partnership, as the deployment of its program tools in this large undertaking represents an export of U.S. goods and services, and allows U.S. firms to engage in various stages of India's smart city development
- The US-India AI Initiative (by the IUSSTF) is an opportunity to formalise the partnership on Artificial Intelligence and is bringing together key stakeholders to use AI to build innovative solutions such as early warning systems and hotspot predictions in pandemic preparedness, sensor-based devices for home monitoring, and mobile technologies for high-quality clinical trials⁸
- In the area of Geospatial Technology and satellite navigation, The U.S. chipmaker Qualcomm Technologies has supported India's homegrown NavIC on some of its mobile platforms. In a press statement, Qualcomm said "The initiative will help accelerate the adoption of NavIC and enhance the geolocation capabilities of mobile, automotive and the Internet of Things (IoT) solutions - with the backing of engineering talent in India."

Several new technologies and trends are emerging rapidly - but which among these will be critical for India and the U.S. to collaborate and sharpen their joint focus on?:

Quantum Technologies

Quantum technologies are a critical area to partner on because they will help nations to solve problems that classical computers are unable to, and have a number of different applications ranging from security to climate technologies. As of December 2021, 36% and 16% of U.S. and Indian organisations respectively were adopting early or advanced stage quantum computing⁹, and India's Ministry of Electronics and IT has provided the first quantum development environment to the scientific and industry communities in the form of a 'Quantum Computer Simulator Toolkit'. As the U.S. and China continue leading this space, India must consolidate its plan for a quantum ecosystem through a

multi-stakeholder network, a clear focus on the types of applications to prioritise, and build capacity, infrastructure, and a talent pool in this specific area. A greater collaboration between the U.S. and India needs to occur in entrepreneurship, policy, academia, and workforce skilling so that quantum communities can benefit from the cross-pollination of expertise.

Cybersecurity

Partnership in cyberspace is and will continue to be an important aspect of the Indo-U.S. relationship. Both countries have intentions to enhance and institutionalise the protection of cyberspace; since cyber issues affect citizens, organisations, and national security, while also impeding advancement in the growth of digital economies, a lot is at stake.

Given that there is already a 'Framework for the U.S.-India Cyber Relationship' signed by the former U.S. President Barack Obama, that is based on many shared principles regarding information and the internet, the current administrations are well-positioned to build on this and emphasise implementation. Examples of implementing a strong cyberinfrastructure would be the promotion of cyber hygiene and ethics among internet-users, cyber risk detection technologies, and a robust cyber recovery plan. Furthermore, several U.S. firms leverage Indian data centres and collaborate with technology partners in India, so a purposeful cyber recovery plan must be cooperative due to the strong digital (and increasing) integration between the two countries.

The issues are not limited to India and the U.S. only, which also indicates that a successful blueprint for cooperation and solutions will offer a template for other countries to follow the Indo-U.S. leadership in this space.

Scaling up computing infrastructure

India & the U.S.'s accelerated investigations in the domains of AI and machine learning requires an equally rapid development of computational capacity to meet the demand for large quantities of data processing, specialised networks, and significant data storage. Both the U.S. and India (along with several other countries such as China, Germany, and Japan) have national supercomputing strategies and investments in supporting programs. However, India is fast becoming a forerunner through its National Supercomputing Mission, though it still has a long way to go in terms of meeting increasing computational demands of researchers, academia, and startups and must also pay attention to applications - such as better infrastructure planning for fast-expanding cities, natural disaster predictions, and genomics. An important opportunity exists here with India's vibrant startup ecosystem to become a tester and optimiser of computational capacity to support advanced AI and other applications, while also addressing critical challenges. This would also be essential as a stepping stone for both countries to make sound progress in quantum technologies.

A Vision for the Future: A Robust Indo-U.S. S&T Partnership

Collaboration on futuristic technologies is critical to solution-specific, ground-up driven innovation. However, a thriving ecosystem that can effectively create, test, and benefit from innovation should also be shaped by principles and programs that surpass the technology itself to consider the markets, skills of the workforce, human rights, ethics, and accessibility. In this regard, there are some critical courses for India and the U.S. to collaborate on:

Foundations to support successful digital economies

While both countries' economic activity has increasingly gone through digital transformation, this trend has been accelerated by the pandemic. The Indian digital ecosystem, still emergent and rapidly growing, is a critical market for both Indian internet users and U.S. technology giants who

will continue investing significantly in India. However, there have been challenges around stifled free speech, privacy concerns, and regulatory barriers minimising access to the digital market. Resolving these issues and building mutual trust at the bilateral dialog and mechanism level will make business more predictable between India and the U.S., and help the relationship to evolve in a way that can accommodate innovation and implementation in the less familiar territory of emerging technologies.

This is important from a technological standpoint too; the backbone of digital transformation to support increasing connectivity among people, enterprises, devices, and data are critical technologies such as AI, autonomous systems, Cloud, and 5G. It will also be important to craft compatible systems of data governance that preserve a secure, open, and democratic internet.

Many of these conversations need to be pursued together rather than in silos in order to build meaningful solutions that help citizens.

Responsible AI & supporting data governance

Given the significant efforts by both countries towards the development of AI-applications, it will be necessary for India and the U.S. to create new AI principles and a system of governance that is congruous with responsible democracies and fair markets. E-commerce giants such as Walmart and Amazon are already investing in leadership and development of AI applications, and Google and Facebook have jointly invested \$10 billion¹⁰ in India's Reliance Jio for AI developments in education and healthcare. As the flywheel takes off, it is essential to start implementing frameworks that support a more responsible AI, such as access to more representative data, data ownership, privacy, transparency of decision-making, and AI's clear role in addressing the goal or need. To this effect, it will be important for India and the U.S. to seek resolution of the data privacy and storage rules, in order to forge a path forward on better algorithmic quality.

Both of these examples also assign value to certain factors that will be important in determining ongoing partnership success in S&T: (1) Engaging policymakers to design policy in a manner that sustains relevance and agility amid the rapid pace of technological materialisation and consumption; (2) cultivating a highly interdisciplinary workforce and creating opportunities for such dialog at all levels will be an important way to empower and engage talent as we enter a new era where technological influence becomes a geopolitical matter; (3) Establishing platforms to create awareness of potential partnerships and cross-pollination of ideas across different S&T entities.

Overall, the U.S. and India are extremely well positioned to chart new paths forward that establish their influence in a highly complex geopolitical world. While shared historical milestones and highly integrated political values have set a strong foundation, moving forward to continue partnering in highly innovative territory would require an evolution of the bilateral frameworks, mechanisms, and innovation principles to resolve hurdles and support the societal needs of India and the U.S. using science and technology

¹<https://www.migrationpolicy.org/article/indian-immigrants-united-states-2019>

²According to the 2021, Forbes Top 50 list of AI startups in the US, 16 were founded by Indian-Americans <https://www.forbes.com/sites/alanohnsman/2021/04/26/ai-50-americas-most-promising-artificial-intelligence-companies/?sh=5e-c249a177cf>

³Amazon- \$1 billion, Facebook- \$6 billion and Google- \$10 billion <https://edition.cnn.com/2020/07/17/tech/google-facebook-india-investment-jio/index.html>

⁴<https://2001-2009.state.gov/p/sca/rls/rm/31553.htm>

⁵<https://thediplomat.com/2021/06/indias-tech-talent-flows-a-win-win-for-india-us-ai-partnership/>

⁶<https://www.idc.com/getdoc.jsp?containerId=prAP48085221>

⁷<https://economictimes.indiatimes.com/news/india/nearly-0-7-pc-of-gdp-spent-on-rd-strengthening-of-st-infra-from-2014-15-to-2018-19-govt/articleshow/85212365.cms?from=mdr>

⁸<https://usiai.usstf.org/usiai-activities>

⁹<https://www.statista.com/statistics/1286920/quantum-adoption-by-country/>

¹⁰<https://www.cNBC.com/2020/07/15/google-jio-platforms-deal.html>