Essay

Technology Ecosystem & National Security

B.M. Suri

Security of nations is continually getting redefined. What used to be simply a defence of borders and maintenance of internal security has now acquired radically new meaning in the last few decades. Over the past two years theIndian nation has faced unprecedented security threats. It suffered the devastating Covid pandemic that exposed weaknesses in its healthcare ecosystem and mechanisms of emergency response. Border clashes with China exposed vulnerabilities related to supply chains. These events --happening simultaneously --posed a unique security threat. It is not yet clear whether the pandemic was caused by a leak from a virology lab or not, but it has raised the possibility of deployment of future bioweapons and the consequent threat to national security.

Recent cyber-attacks and small drone attacks add new dimensions to national security. There is a sudden demand for counter measure technologies. One cannot discount the possibilities of genuine or sabotage-triggered major accidents in industrial oreven nuclear reactors leading to unmanageable health emergencies. There are several lessons to be learnt from major global accidents such as Chernobyl, Fukushima or even Bhopal gas tragedy. In all such emergencies, response time and organizational efforts are of great essence. High technologies can aid immensely in the process of preventing and managing them. Our security planners may need greater imagination, and of course technology, to plan for such and other contingencies, as wide ranging and unpredictable security challenges may emerge in future.

The challenges that national security may face in future demand a high level of technological preparedness. Continual purchase of imported hi-tech products

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(or technologies) may mitigate acute problems but causes increasing vulnerabilities and makes India less *Atmanirbhar* for critical requirements. India urgently needs a huge boost from indigenous technology development (and manufacturing). A composite ecosystem needs to be evolved for this purpose. Two main constituents being STEM (Science, Technology, Engineering & Mathematics) Research and Development (R&D), and manufacturing in high technology areas. These are relatively well recognized and accepted, what is less appreciated is the significance of STEM HE (higher education) in the process. Human resources required for both STEM R&D as well as manufacturing are sourced from STEM HE institutions. Given India's socio-economic conditions, it is imperative that a linkage be established between evolving such an ecosystem, employment scenario and economic growth. Attaining such desired goals may demand major reorientation and reform of various segments of the ecosystem. This requires an urgent national debate among all stakeholders and follow up actions at the highest level.

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The Ecosystem

Where do all the segments of this ecosystem stand today and what kind of symbiotic relationship exists between them, if any? How to define the yardsticks of progress of such an ecosystem? OECD (Organization for Economic Cooperation & Development) group of countries have been very successful in harnessing science and technology for hi-tech industrial growth. Many of them have successfully set up military-industrial complexes. These countries have identified three broad parameters (and few sub-parameters) as markers for monitoring progress in this context. Three parameters are science base, industrial R&D and innovation, and entrepreneurship. Science base is further elaborated as public GERD/GDP (Gross Expenditure on R&D/ Gross Domestic Product), performance of top universities (STEM departments), number of STEM researchers and number and impact of research publications. Industrial R&D is linked to private expenditure on R&D, triadic patents, and trademarks as per GDP. The entrepreneurship is characterized by ease of enterprise and sources of easy finance. For most of the parameters, India stands close to the bottom group of OECD countries, or even further down. But most significant lag is in the case of STEM research universities, human resources, and triadic patents. India stands reasonably well in case of public expenditure on R&D but poor on private contributions.

Evidently two major weak points in building a robust ecosystem are lack of boldness of private industries in spending on R&D and neglect of university STEM departments. Average R&D expenditure distribution of government sector, industries, and universities in OECD group of countries is around 20/60/20. The ratio in the case of India is 65/30/5 (numbers vary with time). While central universities/institutions are relatively better funded, the same is not true of the large number of state universities. This is where most of our STEM workforce exists. Private universities have not yet ventured in a major way on STEM R&D related to manufacturing. Thus, poorer universities, poor choice of R&D directions, lack of participation of large number of STEM researchers/faculty in desired ecosystem, deprive India of exploiting its demographic potential for realizing desired objectives in this ecosystem. This contributes, among many other factors, to poor build-up of patent and trademark assets for the nation, leading to a weak industrial base. It is believed that each good STEM researcher has the potential to generate several times more jobs. There is another important aspect related to the need for evolving the ecosystem. As India strives to get into orbit of trade pacts with technologically advanced nations like the UK, EU and the USA (as the reports suggest), it will become worthwhile to have increased technology parity (at least few sectors) with those nations. This may sound quite ambitious, but India can benefit by chasing such challenges.

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Does India have requisite STEM talent to face such challenges? In his 2016 study *Technological Indian,* Ross Basset[1] researched about Indian STEM talent immigrants in the United States, over a long period of time, and their contributions to the world of technology. He concludes by saying that these 'Technological Indians' (as he prefers to call them) made significant contributions to the global technology development but without benefitting the

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Indian nation. The conclusion is not surprising. There is a widely held belief that India is a young country with strong demographic dividend, and it can afford loss of talent by migration. It is noticeable that India has less than 300 STEM researchers per million of its population while countries like Korea and Israel have more than 7,000 per million (roughly similar number for many OECD countries). Proportionately, their GERD/GDP ratio ranges around 4% compared to 0.69% in case of India. A pertinent question is, availability of how much STEM talent can let one ignore their migration? Does India not have enough technological challenges which can translate into corresponding fellowships, projects, and appropriate jobs for such talent? A robust ecosystem, for stated objectives, must have magnetism to attract and retain STEM talent, and in which fellowships and projects seamlessly mature into bright careers or startups for young scientists and technologists. Creating the right environment and a minimum critical mass of such talent does play a role in encouraging them to remainin the ecosystem.

Significance of Higher R&D

Public investment in STEM higher education has been declining for the last few decades with several attendant consequences. How to make STEM higher education an effective participant in the ecosystem? STEM higher education needs to be treated as a public good for reasons of its intimate linkage to national security, economy and creation of jobs. STEM higher education departments in the country have to be ranked separately from overall university ranking and these ranking methodologies should be linked to the critical needs of the domestic ecosystem. There should be enhanced weightage, in Indian ranking methodology, for research directions linked to industrial R&D in hi-tech sectors and capability to attract and retain talent within the composite ecosystem. Impoverished universities need to be supported by the government in building infrastructure and nurturing quality faculty, with demands on specifically chosen R&D directions. Students, researchers, and faculty may need to be reoriented through greater exposure and mentoring from bigger labs/institutes.

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Private sector industries on the other hand need plenty of incentives of a different kind so that they gradually develop strategic vision based on R&D. The present system of predominantly taxation-based incentives for R&D may not suffice. There should instead be incentives in the form of cheap loans, grants, subsidized use of government infrastructure (for R&D related activities) or even joint projects. Holding hands by way of joint projects between major government labs and private industries can play a big role in exposing private industries/MSME's to culture as well as benefits of R&D. There should also be promised commitments by government of purchase of an innovative product, if developed as per desired specifications. The government should also create conditions for truly fair competition between private and public sector manufacturers, and both have to be incentivized to compete against the highly advantaged MNC's. If the government is not the likely customer, it should facilitate marketing of innovation-based products, as it is doing for Covaxin in foreign countries. The best model of incentives will be like the ones provided recently to covid vaccine developers.

The Covid vaccine is an innovative product developed in India under intense pressure of time and limited resources. It faced not only scientific and technological hurdles but also regulatory speed breakers. For the Indian vaccines, the government pulled all stops to facilitate innovative product development and its commercialization. The Government of India financed the enterprise, tweaking normal financial rules, and Government labs participated in development work by facilitating clinical trials in coordination with the Indian Council of Medical Research (ICMR). It acted as an incubator of sorts. Government regulatory agencies worked at extraordinary speed, by normal Indian standards, to facilitate final clearance. Finally, the Government became a customer of the finished product. Most significant was the government paying huge advances for a product under development and surprisingly the move got widespread support. This was possible as it was a matter of life and death for many of the citizens.

A pertinent question in this context is, should not all R&D and innovators/ entrepreneurs (particularly those related to national security) get the same treatment. It has become clear to one and all that high technology products, like Rome, are not developed in a day and this is true of manufacturing these products with speed and scale. There may not always be a possibility of following the L1 route. This is a major issue, confronting R&D based innovators/manufacturers, requiring resolution by the government. Trained manpower for both R&D and manufacturing of such innovative products is of greatest importance. Covaxin and several other vaccines being produced are shining examples of Make in India – conceiving, designing, and developing all happened within the country. Many of the lessons need to be imbibed by policy makers for other sectors.

Indigenous R&D based Manufacturing

Make in India based on FDI and PLI schemes, in general, are biased to attract capital, promote manufacturing, employment and securing supply chains, rather than indigenous R&D based manufacturing. Faced with acute problems of unemployment, focusing on manufacturing at the current juncture, may seem a pragmatic approach. But looking at the seriousness of the security scenario, it is time India takes cue from US Innovation and Competition Act 2021. This American law provides $100 billion to promote both development of frontier technologies and manufacturing products based on them. India may not have such deep pockets, but it can strive at least to retain and optimally utilize its STEM researchers within the country.

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The process must begin with the government labs, as they spend maximum fraction of national GERD/GDP. Many of these labs, by dint of sustained support from governments over decades, have become storehouses of knowledge, skills as well as world class infrastructure. However, these labs are rigidly attached to their mandates. They can be persuaded to step out a little, of course with augmented support. Their outreach for training human resources (outside their boundaries) or assisting low productivity sectors can make an immense contribution to promoting the ecosystem and the industrial base. It may be worthwhile for them to transform their technology transfer model and instead of transferring spin-off technologies to private industries they should encourage spinning off startups. This will incentivize innovation in the country in a better way with consequential contagion effect. These labs should adopt career growth reforms that encourage patents and development of hi-tech products vis-à-vis research papers. In the long run some of these steps may boost growth of the industrial base, which in turn benefits everyone in the ecosystem.

Even though all stakeholders are responsible for nurturing and contributing to the growth of the industrial base and ecosystem, no single entity can be held responsible.

Each technologically advanced nation has its own mechanisms in place for ensuring coordination between different stakeholders. In India, with many relevant ministries and departments working in silos and often at cross purposes, one can imagine the challenges involved in evolving a coherent ecosystem. Some of the countries successful in achieving these goals have not allowed bureaucracy to hinder their progress and they have utilized their security related R&D for civilian applications too. In this way they plough back dividends from the large market of civilian applications into futuristic security related R&D. These two steps can go a long way in smooth progress.

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India needs to have a National Science Technology & Innovation System-- a high-powered core group that comprises scientists, technologists, industrialists, educationists, representatives of security establishments and contributors from startups. It is essential that this body is spearheaded by a science/technology person of eminence and assisted by the bureaucratic machinery. This body need not be a funding agency; instead, it should be a coordinator between many diverse players. There could be some well-defined expected performance outcomes for this body. First and foremost is the need to identify lacunae in the base of STEM human resources, institutions/industries, critical technologies, and the environment of collaboration. It should interact closely with the long-term strategic planning process and should steer the emphasis away from procurement of security/hi-tech equipment from foreign sources to harnessing knowledge-base and skills available in the country. It should aim at building a hi-tech industrial base in the country, with emphasis on a higher level of value addition, developing advanced materials, components, and subsystems, instead of only big “systems to be indigenized later”.

Increased STEM talent per million and patents per million in the ecosystem, sourced from a larger geographical coverage in the country, must be a major objective of this ecosystem. Encouraging more startups from academics and from tier-2 and tier-3 institutions, facilitated by an appropriate system of mentoring and technology scouts, will expand the hunting ground for talent and startups. It needs to address issues related to hesitancy of institutions and industries in participating actively in unhindered collaboration to advance national security/technology goals. Many times, such hesitancy arises from a lack of exposure to each other's working culture or even lack of clarity on sharing of proprietary rights once the task is completed. This body needs to formulate ageneralized legal framework to facilitate sharing credit/proprietary rights between individual researcher/developer/institution/industry. There could be several such tasks, but the most significant task is to evolve a symbiotic ecosystem of many diverse players complimenting each other.[3]The ecosystem should be like a broad base pyramid, three legs being STEM HE, STEM R&D and manufacturing of hi-tech innovative products. Broad base implies covering development and production of the maximum range of technology components, materials, and hardware.

Conclusion

To summarize, it is evident that in future national security challenges will place major demands on indigenous high technologies and manufacturing based on them. There is a need to evolve a coherently driven composite ecosystem involving all the diverse players. A high -powered science/technology driven body, reporting to highest authority, needs to be set up for this purpose. Having a holistic view, it should spearhead policy reforms as well as requisite actions on the ground, bringing together well- chosen institutions/industries to achieve the objectives of national security.

References

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