S&T and Development Future for India

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Due to foresight in the national movement, India had recognized the importance of science and technology (S&T) for development even before the attainment of Independence and gave it concrete shape during the first two decades after it. With a vision of planned development, and involvement of leading scientists and engineers, newly Independent India embarked on a path that included promotion of autonomous and self-reliant capabilities in S&T, and harnessing the same for social and economic advance, especially for upliftment of backward regions and sections of the population. This vision was broadly shared by the citizenry and across a wide spectrum of interests and political orientations, many of whom also shared a common patriotic zeal.

Unfortunately, the fairly sound and promising foundation laid in the early post-Independence period came to be neglected and even squandered in subsequent periods. With adoption of neo-liberal policies in the '90s onwards, India finds itself at a crossroads in socio-economic development as a whole and with regard to the role of S&T in particular.

Under the present dispensation, the negative trends in S&T have intensified further than ever before. S&T in India has not only fallen much further behind developed countries, but is also lagging behind many developing countries that were on a par with India just a few decades back. The role of S&T in shaping India's development is being sadly ignored. India's dependence on other countries, especially in the West, for advanced technologies has grown substantially and threatens to undermine India's hard won autonomy. In addition, concerted efforts are being made by the present government and forces aligned with it to weaken a scientific attitude and critical thinking among the Indian people, especially its students and youth. All this bodes ill for India's future, and has serious implications notably in this knowledge-era, as discussed in this Note.

AIPSN has embarked on this campaign so as to focus national attention on this crucial issue and promote a mass movement to reverse the current neglect, even undermining, of S&T in India.

Early decades In the initial decades after Independence, the State played the dominant role in building the S&T infrastructure of the nation. The State and state-sector industries led the way in power generation, irrigation, rail and road infrastructure, heavy industry such as steel, cement, fertilizers, machine tools, apart from petroleum, chemicals, pharmaceuticals, ports and highways, civil aviation and so on. That the "commanding heights" of the economy would be kept in the State sector was not simply a unilateral decision by the government of the time. Even large private corporate houses pushed for it because, as they themselves stated, they did not have the requisite capital or capabilities to undertake such tasks. The big corporate houses were quite happy to see the State run these capital intensive and long gestation period industries, while themselves working in light engineering and consumer industry sectors in a highly protected environment with strict restrictions on imports.

With all their limitations, which are discussed briefly below, these Public Sector undertakings set up in the early years of the republic, have played a stellar role in India's industrial development. These State-sector initiatives built the foundation for a stable industrial base and saw India emerge with its own model of development and a well-rounded indigenous industry that was quite uncommon in the developing world in the 1950s through 1970s. Even today they remain or have the potential to be bulwarks of autonomous development in different key spheres, not subservient either to foreign or domestic corporate interests, and capable of playing a leading role in the country's economic development, even though they may require considerable upgrading and re-shaping to meet contemporary requirements.

The State also played the major role in human resource capacity-building especially in S&T, setting up and running a chain of IITs, the CSIR network of applied and industrial research laboratories,

the ICAR agricultural research network and universities etc, wherein the latter were later re-oriented to link up with US agencies during the green revolution.

India's development, and the broad role of S&T within it, was guided by the Planning Commission which drew up 5-year plans, mostly based on sectoral studies, and corresponding resource allocations. The fact that the Prime Minister was the ex-officio Chairperson of the Planning Commission, which had eminent and independent subject experts serving on it, gave the Commission considerable weight in governance, and provided an overall direction under which the different departments of government were expected to function. Important tasks in S&T and planned industrial development were undertaken, and S&T was assigned an important role in shaping specific developmental programmes.

Limitations of the early model Despite several achievements, there were several problems too, which were to adversely reflect on economic development in the 1980s and beyond.

The public sector "core sector" industries progressed reasonably well upto a point, but there was also over-reliance on a few overseas partners and more focus on technology collaborations than on autonomous development of technologies and related capabilities. While this acted as a check on imports, it also combined with protectionist barriers to prevent or inhibit upgrading of capabilities which could enable keeping abreast with global standards in quality and productivity, and lead to comparable spin-offs in related sectors. Consequently, in no area did Indian companies or products emerge as world-leading entities or brands. This was to encourage external dependence and far-reaching technological lag, which got exacerbated by further withdrawal of the State from R&D and industrial investment in the 1980s and beyond.

This was even more true in the private sector, notably in the light engineering and consumer goods sector, again in the context of protectionist government policies. Both quality and productivity lagged far behind international standards, investments were low, and R&D was non-existent, leading to accumulation of huge pent-up demand, craze for and smuggling of imported goods, and poor development of indigenous industrial capability. The example of the 4-wheeler and 2-wheeler automobile industry stands out as an example, where annual production of a few tens of thousands of low quality units by just 2 or 3 manufacturers saw waiting lists of 8-10 years for cars and scooters! (In a later period, after expansion spurred by collaborations with foreign majors, at least some scale and autonomous capability in manufacturing, with a reasonably well established network of component makers, were able to be built.) Consumer durables such as refrigerators and air conditioners, electronic products etc lagged far behind their global counterparts in quality. No culture of innovation was required or cultivated in the highly protected and cartelized manufacturing ecosystem. Low purchasing power of the masses of the people, including the middle class, further lowered the bar and led to the mushrooming of low-priced and low-quality goods emanating from a huge unorganized sector, which somewhat helped with alleviating poverty and unemployment but made no contribution to development of S&T capability in the country.

The almost wholly State-run S&T research and higher education system was a mixed bag, with a few islands of excellence, self-reliance and development of autonomous capability, but with several deficiencies that would later haunt the nation.

Nuclear energy, space and defence research and production were exceptions in many ways. The government invested heavily in these strategic sectors not only in terms of funds but also in terms of human resources and institution building. Scientists and engineers were given leadership of both Atomic Energy and Space sectors, and were also given virtually complete autonomy to build institutions and in-house education and research capabilities, with both departments reporting directly to the Prime Minister. The same pattern, however, was not followed in defence manufacturing and, combined with other factors, the results are there for all to see today when India is the world's largest importer of military hardware..

The chain of over 40 national laboratories under the Council for Scientific & Industrial Research (CSIR) system laid a solid applied research foundation which resulted in establishing a sound base for mostly private industries, notably in leather, glass and ceramics, chemicals and electro-chemicals, metallurgy etc. But a substantial proportion of work was also relatively run-of-the-mill, incremental innovation and industrial application, especially to help private sector industries with their day-to-day

operations and technology management. Due to continued preference of the private sector to import technologies or act as licensed manufacturers or collaborators of MNCs and other foreign manufacturers, and their reluctance to develop their own products and technologies in an atmosphere of high levels of protection, their R&D effort too remained extremely weak and could not help the country establish a strong, modern industrial base with the capacity to innovate and climb up the ladder of the international division of labour.

The emphasis on research within National Laboratories also had some unfortunate outcomes. It placed disproportionate weightage on institutional research and, since funding was also inadequate, relegated research in the University system to a secondary role compared to teaching. This artificial separation between research and teaching has had far-reaching negative impacts on both. It has also meant a pronounced slant towards applied science and research, and corresponding under-emphasis on basic research, with serious consequences for India's future in the knowledge arena.

One area where the R&D system in India, especially in universities, played a significant but controversial role which had a huge impact on India's development trajectory, was in agriculture through what became known as the Green Revolution. While this course of agriculture that India embarked on in the late '70s and '80s transformed India from an international basket case to a more or less self-sufficient country in foodgrain production, it also had many undesirable consequences such as environmental damage, degradation of soil health, excess water use and unsustainable extraction of groundwater, and considerable damage to human health and the environment due to excess use of chemical fertilizers and pesticides, all of which are yet to be satisfactorily tackled. It also led to a lack of emphasis on autonomous agricultural R&D and eventually to an undesirable dependence on multi-national agri-busines companies and their corporate and research priorities.

In overall terms, despite all the positives noted, investment in R&D and in education remained at low levels of under 1 percent and 3-4 percent of GDP respectively, much lower than what was and is required, and what other comparable countries have invested to enable rapid social and economic development. AIPSN and many scientific, educational and other popular organizations have long demanded that at least 3% of GDP in public funds be spent on R&D and 6% on education.

The Lost Decade The 1980s saw many countries, which were at roughly the same level as India in most socio-economic indicators during the 1950s and '60s, gallop ahead both economically and technologically. Japan led the pack early and was followed in East and South-East Asia by South Korea, Hong Kong, Singapore and Taiwan that were dubbed the "Asian Tiger economies" which stormed ahead in economic, industrial and social development, boosted by exports especially to the US which also extended major policy support to them.

With some differences between them, these countries developed a wide-ranging industrial base in electronics, computer chips and other hardware, heavy machinery, automobiles, white goods, ship-building, small aircraft, advanced and precision manufacturing, and robotics. In what is known as the "flying geese formation" or pattern, these countries planned for and took up leadership roles in industrial sectors earlier led by other countries, thus climbing up the global value-chain and acquiring soon-to-be-dominant positions in sector after sector. Thus, Japan took over leadership in automobiles, television and electronic goods, cameras and optical devices, mobile phones and similar devices, in most of which South Korea soon took over organically, so much so that today around 80% of all TV and computer LED screens worldwide, irrespective of brands, are made in Korea. Japanese and Korean companies are also world leaders in automobiles, heavy machinery, robotics, internet-enabled devices etc. These countries did not remain content with establishing themselves in the manufacturing space, but their States also invested substantially in R&D and developed globally ranking knowledge and capabilities in physics, advanced materials, bio-sciences and bio-technology, industrial engineering, high-tech manufacturing etc, recognizing that these would constitute their lever for subsequent phases of growth as well, and invested heavily in R&D, higher education and skilling of their work force.

Thailand, Malaysia, Indonesia and to some extent the Philippines and Vietnam followed, albeit mostly in the industrial sector, each establishing major manufacturing clusters in consumer products, sub-assemblies or components in electronics, computers and accessories, automobiles, processed foods and so on.

It is noteworthy that most of these countries spent, and continue to spend, around 3% of their GDP on R&D and about 5-6% on education.

Of course, there were factors of global political economy involved, such as preferential terms of trade offered by the US and its allies so as to consolidate their influence in East Asia. Also, most of these economies were also badly hit by the global recession following the financial crash in the beginning of this millennium because they were not protected from the global financial markets. But none of these take away from the main trends noted above.

From the 1980s onwards, China developed by leaps and bounds, focusing on industrialization, large-scale domestic manufacture and export of international products, and massive poverty eradication boosting purchasing power and demand, notably through creation of an enormous middle class and a relatively well-off labour population especially in urban areas.

As everyone today knows, China became the "factory of the world." China started off making low-cost versions of global products, but specialized in manufacturing on a mass scale. Gradually it built up capabilities to climb up the value-chain, establishing some of its own brands and, through collaboration with global corporations offering low-cost manufacturing facilities with top-class infrastructure and logistics, also established itself as a major base for offshore production by MNCs. In keeping with the "flying geese" pattern, China too gradually climbed up the global value-chain in electronics, white goods or consumer durables, automobiles etc. Soon, including through mergers and acquisitions as well as strategic overseas investments, China has developed major brands with a global presence, and some of the biggest companies in the world in different categories. China has also invested substantially in R&D and has developed impressive capabilities in advanced research in universities and other institutions. China is now preparing to jump to the near-highest rung of the S&T and industrial ladder, and is working towards its "Made in China 2025" programme aiming to become a global leader in 10 cutting-edge technologies including high-tech manufacturing, aerospace, electric cars, robotics, Artificial Intelligence etc by 2025. Going by past record, they will!

Unfortunately, during this entire period of the 1980's, India went through what has been termed its "lost decade" for many reasons, especially including a serious downplaying of planned development and of the role of S&T in it. The Asian "Tigers" and China, in a planned manner, created major manufacturing hubs in different advanced technologies, and built requisite infrastructure and S&T capabilities including suitably educated and trained work force as well as a knowledge base for further autonomous or self-reliant technological development and scientific research. India missed this opportunity and also failed to prepare itself for a possible second wave one or two decades later, and continues to struggle even today to catch up or even leapfrog over that phase of industrial and S&T development as some had hoped. India especially under the present government continues to shy away from preparing a plan for development of capabilities or knowledge base, particularly in the public sector, in specific areas where this country perceives a need or could have a particular advantage. Instead, the current ruling dispensation has worsened past trends and has chosen to give undue importance to FDI and acquiring technologies through imports or collaboration, even though experience of all other countries teaches the contrary.

Neo-liberalism & Current trends In the 1990s, after a massive economic crisis, India embraced liberalization, privatization and globalization with the active prodding of the IMF and World Bank. Key elements of the neo-liberal economic philosophy were, and continue to be: reduced government spending across the board including in R&D, education, health and other social services, privatization of state-sector enterprises, opening up major sectors of the economy to market forces, opening up the economy to goods and services from other countries, and de-regulation of the economy with as few fetters on the private sector as possible. In industry this has meant dismantling of any measures to protect specific domestic industries based on national interest, dismantling of the state sector and privatization of almost all sectors, and an almost total dependence on technology imports or collaborations with little or no effort to develop autonomous capability even in core or strategic sectors! In S&T, this has come to mean further tightening of the belt in R&D, with the Dehradun Declaration even calling upon CSIR Labs to raise 50% of their funds from private corporations, even though the latter are known to have no interest in research investments.

It has also meant a reversal of the earlier policy of self-reliance and indigenization, and dismantling of environmental regulations. The argument made is why waste time making things in India, when you can buy them from abroad? Why "reinvent the wheel" when you can get foreign companies to set up manufacturing facilities in India? This policy frame is being pursued with renewed zeal by the present government, including an aggressive push for privatization of defence industries, including opening the doors for FDI in the defence sector in the impossible belief that foreign defence manufacturers would set up plants in India and merrily give up their zealously guarded technological know-how. This has not happened anywhere in the world! Even with domestic manufacture by MNCs, other countries have had to specifically plan for and exert themselves to acquire know-how. This is attested by the fact that despite all incentives, including permitting upto 75% FDI under the automatic route, total FDI in defence from 2000-2018 has been a paltry $4.1 million or Rs.35 crore!

All the earlier-noted trends in industry and knowledge generation have now intensified.

In the State sector, while the government is not providing the same kind of encouragement or support that it did in the '60s and '70s, little effort is being made to develop capabilities or products, to achieve global scales. Indian corporates are mostly importing technologies, or entering into collaborative dependencies, and making little or no effort to make Indian products or establish major global brands. While foreign corporates and MNCs have made small beginnings in building export bases in India, for example in compact cars, one hardly think of an Indian company or product category among global leaders outside a handful of industries. Further, compared to manufacturing in the 1980s or '90s, technological advances especially robotics and automation mean that even when investments by foreign companies are in the thousands of crores, employment generated is only a few thousands.

Even in the much touted IT services, there are big companies but few if any original, globally recognized products. While software has made big strides in IT/Business Products Outsourcing Services , and total revenues are of the order of $160 billion (a tiny fraction of GDP), employment in this sector is only around 3.9 million in 2018, and there has been little investment in computer hardware, leave alone any innovation in say, chipsets, sub-assemblies or finished computer products. Even in the world's second largest (and highest growth) cell phone market, there is no major Indian phone brand, except a small number of products assembled from China-made components! India has embarked on a huge solar power programme, but does not make silicon wafers and very few solar panels! Small beginnings made by public sector units have been wound up. If there is such little private sector interest even in independent manufacturing without major collaboration or technology imports, it is no surprise that private sector R&D is virtually zero except for a very small number of organizations.

The Planning Commission has been would up and a Niti Aayog "think tank" has been set up with little permanent expert presence and till now no major sectoral study or report suggesting ways forward. One study on S&T areas has identified major research needs as including rainwater harvesting and nutrition, and the PM himself has urged scientists to concentrate on the latter! Magic pill?

Major developmental programmes have been announced and are being pursued, with no S&T or expert inputs. Bullet Train, Smart Cities, Make in India, Skill India have all been conceived and major schemes launched with almost no S&T inputs or involvement of the S&T community.

It has been explained in detail elsewhere (see SHHD Booklet on Development) why bullet Trains will be too expensive for India while even Rajdhanis and Shatabdis are unable to compete with low air fares. Smart Cities are merely gentrified tiny enclaves for the middle class in existing cities with no holistic thinking or transformative deployment of IT solutions. Make in India has simply not taken off due to fundamental reasons chiefly, it focuses on manufacture (including by foreign companies) rather than on innovation and indigenous product development, <u>including in defence</u>! Even after allowing 100% FDI, only $4 million investment has come in the huge defence sector! And all major MNCs and Indian corporations complain that their major problem operating in India is lack or shortage of skilled manpower! Skill training continues to be divorced from tertiary education and life-long upgradation opportunities like in all major economies.

Budgetary support from the Central Government for research in and use of S&T has continued its declining trend in India since the advent of the neo-liberal economic policy paradigm. The latest budget of 2018 continues this trend. The allocation for S&T now remains at around 0.8% of the gross domestic product (GDP), stagnant for over a decade, compared to well over 2% of GDP in China with a

double-digit annual GDP growth. Even in absolute terms, accounting for inflation, this has meant stagnant spending on R&D. No country has ever advanced without significant state support for R&D.

Today, publicly funded R&D organizations in India are compelled to raise resources from private industry and foreign agencies. The Council of Scientific and Industrial Research (CSIR) network of 40 laboratories, has been forced to accept the so-called Dehradun Declaration to move towards self-financing by earning 50% of its budget from the market rather than government funding. Consequently, with the Indian corporate sector content with importing technologies or being junior partners of foreign collaborators, and highly reluctant to spend on R&D despite a plethora of incentives, publicly funded laboratories have been restricted to salary budgets leaving little for equipment, field experiments and materials. The same condition prevails in Institutes of national importance such as IITs and IISERs (which have actually seen a drop in funding). The social sciences have suffered equally. And there is a clear decline in support for basic research, in institutions and in universities.

India needs to invest far more in science and technology research, including in basic research, as well as in its capabilities and human resources in knowledge generation and imparting/upgrading of skills, so as to promote its genuine development in this knowledge era. Key sectors and/or products need to be identified for mission-mode R&D and translational research, and then for manufacture. The more India falls behind now, the more difficult it will be to catch up and prevent subsequent "lost decades" or keep this country from becoming subservient to others. How does having a "Boeing-India" assembling fighter aircraft in India promote either development of self-reliant S&T capability or national security?

Given the complete lack of interest of the private sector in domestic manufacturing, leave alone R&D, it is high time that relevant public sector units are revived and strengthened in key areas. The private sector can be ancillarized and grow from there on. This is in fact the route being followed in space, nuclear power, missiles, aircraft, so why not in other key sectors?

There is no time to lose. The present trajectory is a dead-end for both manufacturing, and for R&D and growth in capabilities. And the negative results are becoming more visible by the day.