CONCLUSION

Science and Technology (S&T) in India has been geared more towards fulfilling social goals than meeting the defence requirements of the country. The S&T debate in India had to reckon with conflicting views—big science vs. science geared towards the larger societal interest, basic science vs. applied science and more recently, autonomous scientific research vs. market oriented research.

The government sector spends an overwhelming amount on Research and Development (R&D). The private sector spends the least on R&D though the number of R&D units functioning in the private sector far exceed those in the government sector and in spite of the government having offered incentives for investing in R&D. What is more worrisome is that in the private sector, even among award winning R&D units, investment in R&D has not always been on the rise; the investment dipped before registering an increase. India’s efforts to promote indigenous development of technologies have been partly successful, with the general preference being for imported technology. Inadequacy in formulation and failure of implementation of S&T policy can be attributed to a general lack of appreciation of S&T by politicians, bureaucrats and the public. Despite all these, Indian S&T has been forward looking based on a timely recognition of the immense potential that emerging technologies—materials, supercomputers, lasers, superconductivity, etc—and initiation of programmes for their development. These have begun to show results. India’s achievements in areas such as satellites and launch vehicles, electronics, materials and information technology, to name a few, have been noteworthy. Proposals have also been made to develop several strategic technologies
with a view to transforming India into a developed country by the second decade of the next century.

India’s defence R&D activities are meant to enhance self-reliance in weapons and equipment. Besides, defence R&D is undertaken to develop critical components, technologies and industrial infrastructure in order to ensure that embargoes and technology denial regimes do not hinder the progress of programmes aimed at developing state-of-the-art systems. The disintegration of the Soviet Union necessitated the intensification of indigenous efforts to meet the requirements of the armed forces. As a result, India initiated a ten year Self-reliance Plan in 1995 to meet seventy percent of defence requirements through indigenous sources. As yet, the targets set in the Plan have not been met.

The DRDO had to face stiff resistance to its formation. The formation of the DRDO was expedited after the then Defence Minister, Krishna Menon, personally intervened. In the initial years, it received very little support from the Services. From its modest beginnings, the DRDO has grown into a formidable organisation comprising 50 laboratories and the Aeronautical Development Agency. The areas of defence research have expanded over a period of time and now encompass virtually every field of technology which has application for defence.

Even though the activities of the DRDO have grown, expenditure on defence R&D in India continues to be modest. It has risen over the past three and a half decades, notwithstanding the fluctuations. The period between 1989 and 1992 was particularly bad. It now stands at around six per cent of the annual defence budget. Despite repeated recommendations by various Committees of the Indian Parliament,
defence R&D expenditure is yet to reach the ten per cent level.

During the seventies, an approximate one per cent of the total strength of scientists/engineers left the DRDO. Presently, three per cent of engineers/scientists are quitting the DRDO; mostly, they are electronics and software engineers. While in the seventies at least some of those resigning joined the public sector, presently multinational companies are being favoured.

The programmes of the DRDO have gradually evolved from indigenising components in the initial years to undertaking the development of sub-systems in the sixties and the seventies to developing complex, complete weapon systems in the eighties. During the nineties, besides continuing the development of complex weapon systems, the DRDO has undertaken projects for the upgradation and modernisation of ageing weapons. Programmes to develop complex weapon systems could be initiated as a result of the support lent by the political establishment. These programmes were initiated to make India self-sufficient in weapon systems and equipment. They were intended to be a multi-laboratory effort and to generate enthusiasm among scientists. Not long after this line of thinking was accepted the DRDO commenced major projects—which include the Arjun MBT, the LCA and the IGMDP.

The DRDO at one stage decided to closed down several projects in order to impart greater focus of research and also because the DRDO was faced with shortage of financial resources. This as enabled the DRDO to make a better use of its resources.

With a view to involving Indian private industry in defence R&D effort, seven DRDO laboratories have been opened up for participation by the private industry. A
tack force recently submitted its report on evolving a long term partnership. It may not be possible to implement some of its recommendations. For, the task force addressed some recommendations to the Services and the Services were not represented on the Task Force. The DRDO has begun transferring technologies to private industry and has created a special cell for this purpose. Through this, the DRDO hopes to earn royalty. The private industry also stands to benefit by way of commercialising these technologies as well as gaining access to newer technologies. As and when a decision on enhancing the scope of defence exports is taken, the DRDO would be able to contribute significantly as it has already identified fifty processes and components that have export potential.

The Arjun MBT project was initiated with the objective of replacing the Vaijayanta tank, whose gear box and diesel engine were found to be not sturdy enough under battle conditions. Initially, modifications were carried out to improve the quality of performance of the Vaijayanta. However, it was realised that major changes were required, which it was felt would be highly time consuming and could even prove to be counter-productive.

The objective of the LCA project is to achieve self-reliance in designing and producing combat aircraft and bridge design capability in aeronautics. The rising costs of aircraft procurement from abroad underlined the necessity of an indigenous aircraft development programme. The LCA project was launched to replace the MiG aircraft. The LCA was initially planned to serve as a simple ground-attack aircraft, but the objective was later transformed into developing a complex, state-of-the-art multi-role aircraft. Pakistan’s acquisition of F-16s impinged upon the LCA project to the extent
that the LCA has as to be as agile as the F-16 if not more.

Increasing security concerns—of a nuclear China, and a nuclear-capable Pakistan, a quest for self-reliance, the requirements of modernisation, the unwillingness of the Soviet Union to sell the more advanced and larger missiles and the advantage of effectiveness of missiles influenced the launching of the IGMDP.

Exporting the Arjun MBT, the LCA or the missiles being developed under the IGMDP was not a motivating factor in launching these projects. However, there is a possibility of exporting the Arjun, the LCA and the Nag ATGM.

All the three projects in this study have fallen behind schedule. Excepting the Prithvi missile which is in the series production-deployment stage, and the Arjun for which sanction has been accorded for production, the other projects are in various stages of development. In the case of the Agni, Version –I has been developed and tested and Version–II was test-fired in 1998. The missile is yet to be cleared for production. The Nag ATGM has completed most of the tests and is to be cleared for production shortly. The other two missiles—Akash and Trishul—are in various stages of trials. The LCA project is at least seven years behind schedule. The first flight test is due, which might be conducted any time now.

Between 1987 and 1997, Pakistan made three separate agreements with China and Ukraine to bolster its tank regiments. It began to manufacture under license from China the T-69 MBTs, acquired T-85 II Main Battle Tanks (MBTs) from China and placed an order for the acquisition of 320 T-80 UD MBTs from Ukraine. The same year Pakistan entered into an agreement with Belarus for the purchase of 1,920 AT-11
Sniper Anti Tank Missiles for arming the T-80 UD MBTs.

The older generation Vajayantas, which were to have been replaced by the Arjun, have not only been retained in service but had also to be modernised later in order to meet the requirements of the army. The T-72 tanks entered service at around the same time as the Arjun should have been ready for production. At least, their licensed production would, probably, not have been taken up if the Arjun project was completed on time. Now, while the T-72 modernisation project has been taken up there are also pleas for the acquisition of T-90 MBTs followed by their licensed production. Such an event does not bode well for the future of the Arjun.

Even as the LCA project was facing several hurdles in its progress. In the meantime, Pakistan and countries belonging to West Asia and South East Asia began to procure modern aircraft. The induction of fighter aircraft into the airforces of the respective countries of the two regions was more visible especially during the later half of the nineties. That apart, some of the aircraft procurement deals signed during the later half of the eighties began to materialise in the early nineties. Together, the procurements significantly added to the air power of these countries. Along with the aircraft deals, these countries had also signed agreements to equip the aircraft with advanced air-to-surface missiles (ASM) and or air-to-air missiles (AAM), which included the Maverick, Sparrow and Sidewinder missiles.

While several countries of concern to India expanded their respective squadrons India continued to employ a significant number of MiG-21 aircraft which should have been replaced by the LCA. Since the airforce was already experiencing a resource crunch it was left with no alternative than to modernise the existing MiG-21 bis and
MiG-27 fleets. Also, in recent years the combat aircraft strength of the airforce is falling. If the LCA project was completed on time the air force would not have faced the many problems that it is encountering today.

India continues to employ foreign-origin SAMs and ATGMs and these are yet to be replaced by the Akash, Trishul and Nag missiles.

The DRDO has not been able to complete defence R&D projects within the envisaged time and deliver the weapon system or equipment for production. This has left a lot to be desired, except in the case of the Prithvi missile system. It has effected the re-equipment plans of the services, which have taken recourse to not only retaining ageing equipment but also undertaking their mid-life upgradation.

The reasons for the delay in completing defence R&D projects can be put broadly under three categories—financial constraints including poor budgeting of the projects, inefficient management of the projects and technology complications.

The DRDO has not been able to effectively visualise the amount that would be required for implementing defence R&D projects. As a result, the projects have been delayed because of non-availability of finances at crucial stages and there have been frequent and excessive cost-overruns. The more a project gets delayed the more the cost of the project raises, especially for two reasons—one, when the F. E. component is involved the exchange rate varies and two, because of inflation.

The Arjun project was inadequately monitored for a very long period of time. In the absence of an effective monitoring mechanism the project lacked guidance and simply frittered away for a long time. The LCA project suffered due to the inability to
speedily establish a suitable management structure for running the project. It is, indeed, unfortunate that the project was first sanctioned and the mechanism to run the project was decided upon later. Besides, the LCA did not have a whole-time project director for a very long time. This had to some extent had a negative impact on the progress of the project.

The technology complications include change in the scope of the project, change in the strategy and technology denial necessitating indigenous development of technologies.

An important objective of defence R&D through these projects has been to achieve self-reliance in the production of some key weapon systems and equipment and in the development of certain critical technologies. This objective has been partly achieved. The indigenous initiative in the development of critical technologies/components resulted in developing 75 types of critical components, a number of materials and seventeen critical technologies. Further, seventeen critical technologies have been identified for development and some have already been funded. Having recently completed the development of the fly-by-wire-system of the LCA, India’s defence R&D effort demonstrated its ability to quickly overcome the impact of sanctions imposed in May 1998 by the United States. Though the DRDO has been able to develop a number of technologies these have as yet not resulted in delivering the Arjun, the LCA, and some of the missiles for production. An early completion of these projects leading to the production of these weapon systems would determine the success of the Self-reliance Plan, which has already fallen behind targets.

Through involving the industry and academic institutions, Indian defence R&D programmes have enabled the broadening of the R&D base in the country. Indian
industry has contributed to defence R&D projects in a number of areas. Important among these are: development of exotic materials, fabrication of alloys, information technology, electronics, precision engineering, components, aircraft components and avionics. Thus, the Indian industry has gained technology empowerment. Through undertaking these defence R&D programmes a lot of infrastructure—technology development centres, test facilities and production centres—has been built. This would provide a strong base for future defence R&D projects.

Military technology provides spin-off to the civilian sector. Some of the technologies developed in the IGMDP have had the spin-off benefit in the health sector. A number of materials developed for use in the LCA project and IGMDP can find application in the civilian sector of the country. The AUTOLAY software developed for the LCA programme is already being marketed.

Thus, the three military R&D projects have only partly achieved the purposes behind launching them. Most of the weapon systems are yet to be delivered from production. Delays have had adverse implications for the country's security apart from other heavy costs incurred. However, in spite of these failures the achievements have been rather impressive and of tremendous significance for the future. Whereas development of weapon systems is behind schedule, numerous technologies, equipment, processes, sub-systems and defence R&D infrastructure have been indigenously developed, put in place and made available to the industry, research institutions and defence establishments. And all this has been achieved against very heavy odds—particularly the denial of technologies under regimes (Australia Club, London Club, Missile Technology Control Regime and the Wassenaar Arrangement)
for controlling export of dual purpose technologies. The virtual explosion of new
technologies with military use, and fast obsolescence of technologies has been the
other impending factor. The new technologies, processes, material and sub-systems
developed by the DRDO's military R&D have paved the way for undertaking further
R&D activities both in the military and civilian sectors. A major achievement has
been the way the DRDO has conducted its military R&D—its consortium approach,
its mission approach and in general its growing synergy with the private sector and
academic and research institutions. This has considerably expanded the R&D base of
the country. Some extremely valuable lessons have been learnt from past mistakes
and the necessary corrective processes have been set in motion. It is, therefore, hoped
that the management of such projects would be much more efficient in the coming
years.