Chapter – II

Developmental timeline of science and tech in India

A. The Role of Technology in National Defence

Throughout history, technology has influenced the nature of warfare significantly. From machine guns, tanks, submarines and tactical aircraft that were used in the battlefields of World War 1, technology has progressively brought forth nuclear weapons, strategic bombers, inter-continental missiles, precision-guided munitions and integrated communications-satellite-computer systems that have profoundly affected the way nations prepare their defence.¹ Today's technology has reached quite a sophisticated level, producing weapons systems that are said to be "smart". Future advanced technology - such as artificial intelligence, neural and network, and image processing - will produce weapons systems which will not only be "smart" but intelligent as well.²

Implications for National Defence

Just as technology and national defence have long been inter-related, technologists (developers of new technology for defence) and soldiers (executors of national defence and consumers of technology) have long been strategic partners in developing technological solutions in enhancing national defence capability. Soldiers look to the technologists to develop new technology that would enhance defence capabilities by improving operational performance, increasing systems reliability and providing greater mission flexibility while reducing costs, maintenance requirements and time required for the development and production of the technology. Technologists look to defence as a market where their ideas can attract resource support to be tested operationally and as a consumer of their efforts.

Technology is often seen as a panacea in national defence, capable of providing a comparative advantage in maintaining national security, prestige and influence. All major

powers have equipped their military forces with the best available technology to give them decisive advantages over their opponents.³

The major powers also maintain research and development capabilities to avoid being caught without any counter-measures and outwitted in a technological sense. They even conceal their projects from public view to prevent potential opponents from developing counter-measures or similar technology themselves. Nations who feel threatened or have ambitions to extend their borders would accelerate their pace of military innovation for fear that if they lag behind, it would be difficult for them to catch up in terms of higher quality technology. This is because the amount of time required to develop new technology, engineer it into a weapon and manufacture the operational system is greater than that required for developing new technology. By the time the system is delivered, it no longer contains the latest available technology.

**Advantages**

Proponents who argue for greater investment in sophisticated technology for strategic forces would cite the following advantages that technology offers.⁴

a. **Technology enhances tactical victory.**

Superior technology can therefore deter potential opponents even beyond the real increase in military power it provides. It can be employed to counter missile attacks by renegade nuclear powers, defeat aggressors with fewer casualties on all sides and help deter challenges to national security. Wars will continue to be fought with technology. As borne out by the Gulf War I and II, there is no substitute for technological superiority. The armed force that is able to harness and integrate sophisticated technology effectively into its operational doctrine will preserve the lead over its opponents and gain potential victory against numerically superior opponents.

b. **Technology yields payoffs and spin-off uses**

The development and integration of advanced technology will yield many payoffs such as enhanced operational performance and reliability, increased training


realism and effectiveness, reduced purchase and operating costs, and simplified maintenance requirements. Defence-related research will also yield technologies that offer non-defence spin-off uses such as in jet transport aircraft and digital computers.

c. **Technology optimises soldiers' skills.**

The approach in using technology to warfare takes advantage of the citizen soldiers who have grown up with high technology and are particularly adept at using complex machines, electronics devices and computers. It will also overcome constraints imposed by limited human resources.

d. **Technology reduces surprise**

A strong technology research programme, supplemented by an aggressive intelligence programme, will reduce the chances of being surprised by a dramatic advance in an opponent's technology. The intelligence programme would have uncovered any new technologies with potential military applications, on which other nations might be developing.

e. **Technology provides allies with assistance.**

High technology weapons that confer a strong advantage on the battlefield provide an option for providing military assistance to allies. This is preferable to sending fighting troops to their defence. For example, providing an ally with advanced fighter aircraft and the training to operate them could be as effective as sending troops to its defence, but much preferable in political terms.

**Limitations**

There are, however, limits to how aggressive a defence technology programme a nation needs.

- Firstly, new or emergent technology can only produce real advantages when they replace old ones. When a new system is introduced, improvements come rapidly and cheaply. However, after several successive generations, it becomes increasingly difficult to achieve the force multiplication which one initially seeks.
Secondly, given the long gestation period for developing new systems, the very latest weapons when delivered are out-of-date in terms of what technology could offer.

Thirdly, although new technology can enhance defence capabilities, it disrupts established postures and procedures, thus compounding the uncertainties and risks posed by foreign threats. As the US's Strategic Defence Initiative has illustrated, while economic costs and potential benefits of advanced technology are enormous, uncertainties confounding threat assessments, performance evaluations and doctrinal justifications for defence systems are also enormous.⁵

Fourthly, as propounded by critics who view application of technology in defence with suspicion, existence of arms undermines international stability. Lastly, investment in high technology has come - often mistakenly - to be seen as the solution to problems which are essentially political. The technological "quick fix" may seem to permit reduction of military establishments by substituting high technology for manpower. It may also seem to offer much cheaper and more powerful means of destruction, such as nuclear weapons.

Technology will remain vital to national defence. It will change the way the armed forces operate in their core competencies and reshape their operational strategies. A key feature of a credible armed force will be its ability to exploit technology, to create a synergistic effect among its operating systems and organisations.

Technology can be tailored to specific environments leading to highly effective weapon systems that win wars, without having to rely on the other countries' technology plans and priorities and weapon concepts. For example, the British were the first to employ the concept of flying air-planes from ships but they failed to incorporate carrier aviation into the British Royal Navy. They were then focused on the problem of combating in the confined waters of the North Sea, the Mediterranean Sea and the Atlantic Ocean. Instead, the Americans and Japanese were the first to develop carrier aviation due to their need to travel long distances and fight major naval engagements.

To maintain a prudent degree of military superiority over potential opponents, steady efforts will be required to examine and understand how new and evolving technology could be exploited to provide superior weapons and supporting system for the armed force. New technology should release the constraints upon present operating practices rather than being constrained by them. The rewards from new technology will not come from one-to-one

⁵ Defense Technology, Asa A. Clark IV and John F; Praeger Publishers, USA, 1989
substitutions of better weapons for old ones. New types of weapon systems may have to be developed and tested to understand their potential for altering the art of war.

Developmental Timeline of science and technology in India

Science and technology have been central to India’s development efforts since achieving independence. Jawaharlal Nehru, the first Prime Minister, was a firm believer in the crucial importance of science and technology for economic growth and social transformation, and helped lay a firm foundation of science and science education in the country. Along with a focus on industrialization and rural growth, India’s development plans over the subsequent six decades have channeled substantial resources to education, training and research in science and technology (S&T). The country today has a vast S&T infrastructure comprising national laboratories and institutes, more than 200 universities and over 12,000 colleges. With its flagship nuclear and space programs, high profile in information technology services and pharmaceuticals, and a growing emergence in the world economy, Indian science and technology has come a long way from its modest beginnings.

a. Scientific Temper in India

Scientific temper is an indigenous discourse rich with potential for cross cultural, gender and environmental sensitivity and laden with a continuous struggle against the ill effects of technology on one hand and extra scientific belief systems on the other. It is necessary for people to deal rationally with every mundane issue of the society. In India, the notion of scientific temper was well articulated by the first Prime Minister of India, Pandit Jawaharlal Nehru “disseminating science is constitutional obligation”.

b. Early Indian Science

Can it be said that the early pioneers of India lacked in scientific temper? How did they achieve advances in so many fields? Is it not a fact that they identified an infinite number of sources of food and took to their cultivation? Did they not locate a number of metal deposits and developed techniques of mining and processing to get the metal out? The numerous abandoned mines and enormous heaps of slag, the exquisite images of bronzes, testify to their knowledge in these fields. Were they not master builders of breath-taking monuments testifying to their remarkable architectural skills? Is it not true that in observational
astronomy and in mathematical calculations their knowledge far excelled than of any other country of that period and the conception of zero and value-based decimal system and their knowledge of numbers placed them in the forefront? The Indian numbers were a hit across the Islamic world before they were finally brought to Europe and the Indian figures came to be called Arabic numerals. Sham Banerjee takes the story a hundred years forward when the German mathematician Gottfried Leibnits invented the binary system using the Adam and Eve of mathematics – one and zero. It is common knowledge that the two digit binary system has come to dominate every part of human life. This is not to suggest that Indian mathematicians knew computer language but that left to their own way of reasoning they could have evolved their own system of computing.

Their knowledge of the human anatomy, the healing and curative properties of innumerable plants and animal products (collectively known by the name Ayurveda), and yoga was considerable. What was wrong with their belief was that diseases were the punishment of Gods for human transgressions? Did not such belief exercise control over licentious living? The universities of Taxila and Nalanda were noted for attracting numerous scholars to undertake arduous journey from different parts of Asia. Indians were the producers of the finest textiles, greatly prized by the West.

These are no mean achievements but a full account of this traditional knowledge and the stages by which it was accumulated has unfortunately not even been attempted. The University education ushered in by the British overlords did not encourage undertaking any such studies. Macaulay, the architect of English education policy in India, had a great contempt for Indian scholarship and effectively prevented the study of ancient languages and texts. The Universities which he helped to establish at Calcutta (Kolkata), Bombay (Mumbai) and Madras (Chennai) were fashioned wholly after the western model with no reference to past achievements of Science in India. Sanskrit was condemned as a dead language and never formed part of education of an average Indian scholar. The same neglect is continuing even after Independence and has extended to the study of regional languages. While we are grateful for the introduction of the English language which has opened the gates wide for acquisition of new knowledge in a variety of disciplines, we cannot but point out the great harm done by cutting out the roots of Indian culture. The neglect of Vedic scholars is an unfortunate chapter in the development of Indian scientific temper.
The question is often asked why an Industrial Revolution similar to that which took place in England and Europe did not happen in India. This has to be ascribed to the indifference to the history of development of Indian science since the sixth century. The science being taught in India is wholly western in origin and no part of it could be claimed as having roots in India. The March, 2009, issue of ‘Dream 2047’, for example, has an article on Hipparchus of Rhodes calling him the greatest astronomer of antiquity. The article is illustrated with sketches of Ptolemy, Pliny, Plutarch, Aristarchus, but hardly any mention is made of Aryabhata, Varahamihira, Bhaskara, Vallabhacharya and other great astronomers of India. Their omission is regrettable, as India had made significant progress in observational astronomy. Students of science graduating from our research institutes are not made to feel proud of their past achievements. The false impression that the start of scientific enquiry is largely western in origin and that scientific temper is alien to Indian culture, one oriented towards spirituality and cultivation of occult practices needs to be corrected. Honourable exceptions are Srinivasa Ramanujan, J.C. Bose, C.V. Raman, S.N. Bose, K.S. Krishnan, G.N. Ramachandran, V.S. Vekatsubramanian (who built an indigenous mass spectrometer). This is an erroneous mindset which has helped to develop a culture of mediocrity, always seeking for an external source for guidance. In the guise of doing basic research, a practice of narrowness, of over-specialization and contempt for students of other scientific disciplines is developing. If such an attitude is allowed to take root, it will finally lead to the end of science and to the triumph of technology, for the most sophisticated instruments are essential for their highly specialised research. As such instruments take over; the process of thinking may even be eliminated altogether. Scientific temper is not a virtue copied from elsewhere. It is an inborn ability which should guide Indian thought and should form the foundation for all development. It should be like the Indian banyan tree (ficus religiosa) which perpetuates itself sending out branches below and above nourished by knowledge and is imperishable. Outside knowledge grafted from time to time cannot possess the same vitality which is a basic requirement for natural growth.

c. Nehru’s contribution in developing scientific temper:

The base of the scientific and technological developments in India was made by our visionary first Prime Minister Pt. Jawahar Lal Nehru. He laid the solid foundations for
development of science and technology in India and passed a number of resolutions for the same.

1. **SCIENCE POLICY RESOLUTION, 1958**

The government as well as the scientific community of free India realised quite early that science and technology need to be fostered and encouraged in order to contribute to the agricultural and industrial progress of the country as well as to its defence. Impressed by the efficacy of planning in bringing about economic development, Prime Minister Nehru introduced the same in India and linked the development of Science to planning. For him science was a quest for 'truth'-a truth that was neither communist nor capitalist. He strongly advocated the inculcation of 'scientific temper' and 'free inquiry'. The year 1957 was the year of the Sputnik. At a time when the bullock cart was still the chief mode of transport in India the then Soviet Union sent a vehicle into space. As much as the Sputnik spurred scientific activity across the world, its ripples were felt in India too. Delivering the inaugural address at the 1958 session of the Indian Science Congress, Nehru expressed his amazement at this development in science. The foundations of modern day science in India were about to be laid. The direction which science policy in India would take was outlined by Nehru during the course of his address. He said:

"Why does science make progress? ...I suppose, because science is encouraged, science is considered important, and scientists are given importance and status, so that more and more people are attracted to science ... you must consider science and the spirit and temper of science as important...Facilities should be given for the advancement of science, the scientists and the universities wherever this work is done ...it is the function of the state to encourage science ... because it is the right thing to do ... [and also because it is] important to do so. If you do not, you get left behind, you get weak."

Two months after his address to the Science Congress, Prime Minister Nehru personally introduced the Science Policy Resolution (SPR) in Parliament on 4 March 1958. This Resolution delineates the objectives of India's science policy. The Resolution sought to 'foster, promote and sustain' science education and scientific research-both pure and applied, create a pool of scientific personnel and encourage 'individual initiative' and 'creative talent'. Importantly, and this is what concerns us—the objective was also:

6Baldev Singh, ed., "Jawahar Lal Nehru on Science"; New Delhi 1986

7Inaugral address at the 45th session of the Indians Science Congress, Madras, 6 Jan 1958
• to encourage, and initiate, with all possible speed, programs for the training of scientific and technical personnel, on a scale adequate to fulfill the country's needs in science, agriculture, industry and defence.

• and in general, to secure for the people of the country all the benefits that can accrue from the acquisition and application of scientific knowledge.

The efforts in the initial years after independence concentrated on laying the foundations of science. A chain of laboratories were inaugurated and science education was promoted for creating a science base in the country. As stated in the Science Policy Resolution, organising science for defence was among the stated objectives of the government. It is, of course, true that among the list of priorities defence figures last in the objectives stated in the Resolution. What is important, and rightly so, is that it is one of the objectives. Moreover, the government sought to derive every advantage that science could bestow upon its people. If one were to interpret this objective in a broader sense, implicit in the objective is a desire to employ science towards the defence needs of the country and derive the benefits that science could impart. Science has numerous applications and in various fields—one of them being in defence. Speaking at the Third Defence Science Conference, a month after the Science Policy Resolution was moved in Parliament, and a few months after the Defence Research and Development Organisation (DRDO) was formed, the first Scientific Advisor to the Defence Minister made an impassioned presentation declaring the requirement of expanding defence research activity in the country and the need for enhanced allocation to defence research. However, he quickly added that the economic condition of the country would not permit higher spending and, therefore, it was out of the question to make available ten per cent of the defence budget for defence Research and Development (R&D). The inference that one could draw from the line of thinking of the first Prime Minister and the first Defence Science Advisor is that the development needs of the country figured more prominently than organising science for defence.

2. SCIENCE POLICY RESOLUTION: FOLLOW UP

In order to review the implementation of the SPR a conference of scientists was organised in 1963, five years after the SPR was moved. The meeting was addressed by Prime Minister Nehru and the then Minister for Science and Culture, Humayun Kabir. The

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8 D.S. Kothari, "Science And Defence"; Paper presented at the Third Defence Science Conference, New Delhi, April 1958
Committee on Defence was headed by the then Scientific Advisor to the Defence Minister, S. Bhagavantam, a scientist of considerable repute, who was at one time the Director of the Indian Institute of Science, Bangalore, and a former junior colleague of C. V. Raman.

3. **After 1962**

The 1962 India-China War stirred the scientific community into action. The scientists expressed an intense desire to participate in the defence effort of the country. They were, however, lacking in the knowledge of the extent to which they could associate themselves. A leading journal of those times wrote in its editorial that "... the nature and the size of research problems connected with defence are not known to scientists and technologists". 9 Not only this, the scientists were nearly angry that the government gave no serious thought to the need for defence and on the urgency of organising the resources of the country for this purpose. This was mostly because at that time there was hardly any co-ordination between defence R&D and scientific research being conducted elsewhere in the country. The scientists honestly felt that defence R&D effort needed the active involvement of scientists outside the Defence Science Organisation. Under these circumstances it was suggested that "in this country it may be worth considering whether association of uncommitted scientists with the solution of some of our defence problems may not turn out to be fruitful". 10 It was a time when defence R&D was conducted in a state of isolation and secrecy. Therefore, the science community suggested that the government should take a small group of scientists into confidence and discuss with them the contribution they could make. Discussions were held between the Directors of national research laboratories and officers of the Defence Science Organisation in order to mobilise the scientific effort to defend it. What followed was the constitution of a Steering Committee. The Steering Committee had the then Director General of the Council for Scientific and Industrial Relations (CSIR) as its chairman. Besides reviewing the resource availability in the country it recommended the creation of 'defence cells' in prestigious national laboratories to carry out research of relevance to defence. At this juncture it was asked by the science community if similar cells could not be formed in other research centres as well as universities.

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Over the years the desirability and usefulness of marshalling all the available resources so as to employ them in defence research as and when the need was felt gained credence. A defence co-ordination unit was set up in the DRDO in 1962 to co-ordinate with the CSIR with the objective of 'joint planning of programmes' and 'co-ordinating CSIR R&D programmes with defence requirements. The Unit is presided over by a Steering Committee, whose Chairman is the Director General of the CSIR. At the same time, the DRDO also initiated collaboration with universities and Indian Institutes of Technologies (IITs). A defence co-ordination unit was set up in the DRDO in 1962 to co-ordinate with the CSIR with the objective of 'joint planning of programmes' and co-ordinating CSIR R&D programmes with defence requirements'6 . The Unit is presided over by a Steering Committee, whose Chairman is the Director General of the CSIR. At the same time, the DRDO also initiated collaboration with universities and Indian Institutes of Technologies (IITs). The nature of the interaction was, and still is, in the form of conducting joint-symposia, assigning defence R&D projects to universities and IITs, mutual visits and lectures and participation by the DRDO in the summer school programmes of universities. Nonetheless, even as late as in the mid-seventies no significant degree of closer co-ordination between defence R&D and civilian R&D could be established. As if this was not bad enough the scientific and technological strength did not match the requirements of the defence R&D effort. A person of no less an authority than the incumbent Scientific Advisor to the Defence Minister expressed the opinion that:

“planned effort should be made, in a manner more purposeful than has been done in the past, to keep them in such a state of preparedness that all of them be harnessed, at short notice, to defence effort, if and when so desired. It is essential to leave them where they are during normal times and encourage them to follow their scientific avocations, but provide them with liberal support to grow fast enough and keep abreast of modern developments, so as to be useful during and keep abreast of modern developments, so as to be useful during an emergency.”12

What we understand is that, even at that time the invitation to scientists outside the defence laboratories was not an open one. They were expected to keep themselves in a state

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11 Ibid. p. 91-92
of 'scientific alert' so that their services could be called upon when an emergency arose. The situation did not take long to change.

By 1979 defence R&D started to make fervent appeals to the science community as well as the industry to join hands with it. The then Scientific Advisor to the Defence Minister allayed the prevailing belief that defence R&D was shrouded in secrecy and went on to state thus:

"Defence Science requires the help of all laboratories and industry in the country.... It should be possible for more scientists and laboratories to volunteer to play a positive role in the indigenous design and development of defence equipment for the country. This would be a great contribution to the nation and a more economical way of looking at the defence effort"\(^\text{13}\)

Hence, two observations would be in order. One, it was a reversal of roles for defence R&D and the science community. The science community, from having volunteered to do everything within its capability, including offering its services at no cost at all, in the aftermath of the 1962 War, had, now, to be prodded to collaborate in the defence effort of the country. Two, the appeal, including that to the industry, was sent on the early eve of the commencement of high-technology defence R&D projects.

**B. Developments After Nehru**

1. **SCIENCE AND TECHNOLOGY PLAN, 1974**

The National Committee on Science and Technology initially prepared an approach to S&T Plan in 1973 and, as a maiden venture, prepared a comprehensive S&T Plan in 1974. The Approach Paper to the Plan identified a number of thrust areas like agriculture, dairy, textiles, health and family planning, water supply and sanitation, coal, oil, power, nuclear energy, alternative sources of energy, natural resources, integrated river basin development, minerals, marine resources, iron, steel, copper and zinc, heavy engineering, chemicals, materials, transportation, cryogenics, solar energy, magneto-hydrodynamic power generation, desalination, biological control of pests and space technology, etc.

The Plan conducted a critical examination of 24 sectors "with a view to evolving suitable programmes of research, development and design for accomplishing time bound targets. The Plan was geared towards import substitution, adaptation of imported technology, enhancement of industrial productivity, export promotion, building up capabilities in frontier areas and augmentation of R&D". The preparation of the Plan was a largely participatory effort, which involved the participation of more than 2,500 scientists and the sub-committees connected with its preparation having visited several parts of the country to discuss at length the needs and the potential with producers and users of R&D ... as well as having attempted to involve private R&D for more purposeful ends.

The implementation of the Plan proceeded along three broad directions: encouragement to commercialisation of indigenously developed technologies and R&D by providing incentives; organisational and managerial reforms; setting up of new science and technology institutions, which included the National Remote Sensing Agency (NRSA), Germ Plasm Bank, Offshore Engineering Group, Engineers India, etc. The S&T Plan had the singular merit of being participatory in nature. Besides, the Plan sought to promote R&D and establish linkages between the laboratory and the industry. Moreover, a large number of areas were identified for promotion. However, the implementation of the Plan left much to be desired. The many areas that were identified may have, to an extent, contributed to this result, for the reason that the focus was lost and there was competition for allocations.

2. TECHNOLOGY POLICY STATEMENT, 1983

The then National Council for Science and Technology prepared a Technology Policy Statement in the late seventies for the consideration of the Cabinet. However, due to political uncertainty in India at that time a decision was not taken in this regard. After the Congress came to power in 1980 the matter once again came up before the Cabinet. Finally, in January 1983, the government issued the Technology Policy Statement (TPS). Though the TPS was

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14 S. K. Mukherjee and B. V. Subbarayappa, eds., Science in India: A Changing Profile [New Delhi, 1984],
15 C. Subramaniam, "Whither Science and Technology in India -f", The Hindu (Madras), 29 February 1996
16 Ashok Parthasarathy, "India's Efforts to Build an Autonomous Capacity in Science and Technology for Development", Development Dialogue, Vol. 1, 1979,
17 Government of India, Department of Science and Technology (henceforth DST), Science Advisory Committee to the Cabinet, Annual Report, 1981-82 [New Delhi, 1982],
issued the question of formulating a mechanism for its implementation remained\textsuperscript{18}. Subsequently a high level Technology Policy Implementation Committee was constituted\textsuperscript{19}.

The TPS aimed at developing indigenous technology and efficiently absorbing and adapting imported technology. It sought to correct regional imbalances in development, serve the needs of the underprivileged sections of the society and help India achieve technological self-reliance. The TPS also aimed at fostering linkages between the various S&T institutions in order to generate technology which would impart economic benefit. The TPS laid 'special emphasis on agriculture, including dryland farming, optimum utilisation of water resources, pulses and oils seeds, drinking water, nutrition, reduction of blindness eradication of communicable diseases, low-cost housing, renewable non-conventional energy resources and industrial development\textsuperscript{20}. The TPS declared that 'full support' would be given to the development of indigenous technologies, especially in critical and vulnerable areas and in high-value added items. The TPS recognised the advantages of being self-reliant in technology\textsuperscript{21}.

3. **AFTER THE 1983 TECHNOLOGY POLICY STATEMENT**

In order to disseminate the advantages of the application of technology to a wider section of the society the government had set up National Technology Missions between 1985 and 1989 in the areas of rural drinking water; immunisation of pregnant women and children; adult literacy; self-sufficiency in edible oils; improving telecommunication networks; dairy development; and wasteland development\textsuperscript{22}.

Unlike in the seventies when indigenous initiative, expansion and modernisation were pursued indigenous efforts in S&T seem to have received a setback during the eighties, even though the TPS sought to support the development of indigenous technology. This trend was not only questioned but made one commentator to remark that the launching of the Agni missile was a lesson for indigenous effort and that it was all the more relevant for all areas of S&T\textsuperscript{23}. The general trend was for a preference for foreign collaboration rather than on indigenous development.

Even after the TPS was issued, it was realised that something was amiss. During a meeting of the Parliamentary Consultative on Science and Technology in 1988, it was stated

\textsuperscript{18} Technology Policy Statement [New Delhi, 1983].
\textsuperscript{19} DST, Annual Report, 1989-90 [New Delhi, 1990],
\textsuperscript{20} DST, Technology Policy Statement, n.15.
\textsuperscript{21} "Undeclared Embargo" written by Patriot (New Delhi), 19 October 1982,
\textsuperscript{22} DST, Annual Report, 1989-90, n. 16
\textsuperscript{23} Balraj Mehta, "High Technology and Growth", Tribune, 1 June 1989
that there was a need to clearly define the S&T objectives of the country for the next ten to fifteen years, besides identifying select R&D areas and establishing technology missions. With this in view, in July 1988 the Science Advisory Council to the Prime Minister (SACC) prepared An Approach to a Perspective Plan for 2001 A. D. Role of Science and Technology (APP).

The Approach to a Perspective Plan (APP) hoped to achieve 'deceleration in population growth, a two-fold increase in food production, health for all, literacy for a vast majority, better management of energy and transportation, better communication facilities in rural as well as urban areas, reversal in erosion of ecology, address problems of rural housing and selective habitat, excellence in selected frontiers of S&T and reduce poverty and unemployment. From the objectives of the APP one could gauge that the planners of the day laid stress on removing the shortcomings that were confronting the country by providing S&T inputs. While on the one hand improving the general living conditions of the people needed to be addressed in a systematic manner it was also recognised that a concerted effort should be made to pursue R&D in frontiers areas of technology with a view to achieving self-reliance in these areas.

In order to achieve the objectives stated in the APP the SACC recommended the launching of 'national programs'. Following the recommendation three such programmes were launched between 1989 and 1993: 'New Fibres and Composites Programme', 'National Superconductivity Programme' and 'National Laser Programme. The National Superconductivity Programme supported 67 projects in basic research, technology development and applications.

During the same time Technology Missions were created in the areas of parallel processing systems, biosensors and erasable disk. Subsequently, a 'massive' exercise for launching Mission Programmes was planned. These were planned in the fields of sugar production technology, advanced composites, next generation massively parallel supercomputer, new electronics materials and components, micro-electronics and photonics, information technology and future air navigation systems, etc.

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24 Reported in Hindustan Times (New Delhi), 18 February 1988.
25 An Approach to a Perspective Plan for 2001 A. D., Role of Science and Technology [New Delhi, 1988]
26 DST; Annual Report, 1988-89 [New Delhi, 1989],
27 Annual Report, 1990–91 [New Delhi, 1991], p. 18
Another program that has been launched recently is the 'Critical Technologies Program'. Under this program, the Department of Science and Technology supports research in a number of areas including sensors, fuzzy logic-based systems, intelligent processing of materials, etc\textsuperscript{29}.

In view of the various programs launched in many areas of advanced technologies in the recent past, it could be seen that the efforts aimed at achieving self-reliance in technology development have gained momentum. Exhorting scientists to strive hard for developing advanced technologies, the then Prime Minister, H. D. Deve Gowda, asked scientists to accept the challenge posed by the reluctance of advanced countries to transfer sophisticated technology in the frontier areas of science and technology\textsuperscript{30}.

The development of strategic technologies is one of the chief aims of India, as it approaches the next millennium. Recently, a panel of the Technology Information and Forecasting Council (TIFAC), Department of Science and Technology, identified areas that are critical to the growth of strategic industries in India. In fact, the TIFAC itself was created upon the recommendation of the SACC. The reason for identifying areas that are critical to the growth of strategic technologies is that the industrially advance countries have already established themselves in these areas, derived economic prosperity and have begun to impose various control regimes on those countries that were attempting to establish an indigenous base in strategic areas; the six broad areas identified include.\textsuperscript{31}

- Aviation: aircraft, propulsion/airframe technology, avionics and communication
- Electronics: Micro-electronics, wireless technology, displays
- Sensors
- Space communication and remote sensing: Communication, remote sensing, meteorology
- Critical materials and processing: Critical materials, structures, processing; and
- Robotics and artificial intelligence

The proposal is to develop various technologies in the broad areas listed above within a time span of twenty five years. The target periods have been classified as short, medium and long term-year 2000, year 2010 and year 2020 respectively. The Panel recommended a shift from know-how to know-why, alliances for realising the development of critical technologies, a time-bound mission-mode programmes, encouragement and increased

\textsuperscript{29}DST, Annual Report, 1994-95 [New Delhi, 1995].
\textsuperscript{30}Prime Ministers address to the 84th Session of the Indian Science Congress, 24 January 1997, New Delhi
\textsuperscript{31}DST, TIFAC, Strategic Technologies [New Delhi, 1996]
allocation for R&D, policies aimed at greater partnership between government and industry, etc. Partnership with national laboratories and defence laboratories would, the industry has been told, facilitate quicker acquisition of technologies and less investment in R&D.\textsuperscript{32}

Whereas the specific areas identified by the Panel are those that merit special attention, and on which the future of strategic industries of the country is dependent, work has already been commenced on a vast number of areas, which would fit into the broader areas listed above. An interesting exercise was conducted by a senior defence scientist wherein the areas that the U. S. considered critical and in which India has an abiding interest were listed which include\textsuperscript{33}

- Parallel computer architectures
- Microelectronic circuits and their application
- Fibre optics
- Signature control
- Automatic target recognition
- High power microwaves
- Preparation of gallium arsenide and other compound semiconductors
- Machine intelligence/robotics
- Sensitive radars
- Phased arrays
- Computational fluid dynamics
- Hyper velocity projectiles
- Software productivity
- Simulation and modelling
- Passive sensors
- Data fusion
- Air breathing propulsion
- High-temperature and high-strength composite materials
- Superconductivity

4. R&D ACTIVITY

\textsuperscript{32}Abdul Kalam's speech at a seminar reported in The Hindu, 18 September 1995
\textsuperscript{33}K. Santhanam, "Opportunities and Prospects for Indo-U. S. Cooperation in Defense Technologies", Second IDSA-NDU Seminar on Indo-U. S. Defence Cooperation
The initial planners of S&T in India attached immense significance to R&D. The idea was to utilise technology developed through indigenous R&D to make up for lack of resources. The imperative of conducting R&D was best stated by one of India's well-known scientists in these words:

"Most developing countries do not have much to sell except agricultural products, raw material, arts, crafts and clothes. If their industries have to be competitive they have to do R&D of a high calibre and produce technologies comparable to those from the advanced countries. [This is especially true of India]."

India today has a vast R&D network and a large pool of manpower. The CSIR is the principal body that is charged with the task of creating an R&D base in the country. Over the years, a chain of 200 national laboratories, an almost equal number of R&D institutions in the central sector and about 1,000 R&D units in the industrial sector have been established. Besides, R&D activity is conducted by the Department of Atomic Energy (DAE), Department of Space (DoS), Department of Electronics (DoE), Indian Council for Agricultural Research (ICAR), Indian Council for Medical Research (ICMR), public sector undertakings and private industry.

The meagre resources made available to science in the country prompted leading science luminaries, as well as those interested in science, to debate on how best to employ these resources. In order to achieve rapid progress, S&T was seen as a useful tool. With this in view, efforts began in several areas. These also included areas in 'big science' such as atomic energy and space. Under these circumstances, there was a widespread criticism of the choice of the areas that received funding and encouragement.

R&D Expenditure by Major Scientific Agencies, 1976 to 1983

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<tbody>
<tr>
<td>DAE</td>
<td>2445.63</td>
<td>5831.74</td>
<td>6082.32</td>
<td>6178.46</td>
<td>7623.24</td>
<td>8926.06</td>
<td>10563.1</td>
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<tr>
<td>CSIR</td>
<td>2500.77</td>
<td>4125.71</td>
<td>5592.39</td>
<td>5918.99</td>
<td>7281.79</td>
<td>7877.08</td>
<td>10081.5</td>
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<tr>
<td>DRDO</td>
<td>3428.97</td>
<td>5065.00</td>
<td>6678.61</td>
<td>9662.91</td>
<td>7970.00</td>
<td>10483.3</td>
<td>12199.9</td>
</tr>
<tr>
<td>ICAR</td>
<td>2408.42</td>
<td>3739.24</td>
<td>5603.61</td>
<td>7739.81</td>
<td>6599.27</td>
<td>11149.5</td>
<td>13121.5</td>
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34 C. N. R. Rao, "Role of Science and Technology in Society", National Herald (New Delhi), 10 January 1992

35 The Hindu, 12 November 1994

Note- All figures in rupees lakhs

One section felt that excessive importance was being given to big science at the cost of more socially useful areas like food, textiles, housing, etc. As the R&D work began to focus on market-oriented research with the unveiling of the New Economic Policy (NEP) in 1991, it was pointed that it would be more prudent to conduct research that had 'an autonomous justification' and relevance to a greater majority of the people than to 'anchor' it on "market principles and neo-liberal ideology". One reputed scientist strongly favoured investing in 'technologies, processes and products in a mission mode, as this would yield more dividends.'

The following table presents the data on the growth of R&D manpower in India. As can be seen from the table, the total number of those connected with KoGD work nearly tripled in a span of twenty years, between 1974 and 1994. The number of those involved directly in R&D activity rose by more than two times during the same period.

### R&D Manpower in India

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<tr>
<td>R&amp;D</td>
<td>48328</td>
<td>54105</td>
<td>64875</td>
<td>78036</td>
<td>85309</td>
<td>96927</td>
<td>105936</td>
<td>95786</td>
<td>114403</td>
</tr>
<tr>
<td>Auxiliary</td>
<td>27882</td>
<td>41753</td>
<td>58142</td>
<td>72233</td>
<td>70233</td>
<td>80956</td>
<td>96737</td>
<td>98202</td>
<td>98769</td>
</tr>
<tr>
<td>Administration</td>
<td>33556</td>
<td>51965</td>
<td>61079</td>
<td>71680</td>
<td>79093</td>
<td>86398</td>
<td>98204</td>
<td>99660</td>
<td>101317</td>
</tr>
<tr>
<td>Total</td>
<td>109766</td>
<td>147823</td>
<td>184096</td>
<td>221949</td>
<td>240697</td>
<td>267616</td>
<td>300887</td>
<td>293348</td>
<td></td>
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</tbody>
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From tables it can be noticed that the central sector spends an overwhelming amount on R&D while the contribution to R&D by the state sector and the private sector is quite low. The contribution of the private sector to R&D is distressing. The private sector contributes no more than two per cent of the total R&D expenditure in the country, though in the number of R&D units functioning, it far surpasses that of the public sector. The SACC felt that in most cases the private industry ran R&D units to take advantage of tax concessions and "in the name of R&D, only the mundane functions of quality control and analytical functions are carried out". Agreeing with the opinion expressed by the SACC, an anonymous author felt that "most of the activity that passes for R&D seems to be more for tax avoidance than purposive research".

The government levies an 'R&D Cess' on the import of technologies on all industrial concerns for any foreign collaboration agreement approved in accordance with the Industrial Policy of the government, on payments made for the import of technology; cost of drawings and designs in terms of any foreign collaboration agreement; and deputation of technical personnel to India in terms of any foreign collaboration agreement. Besides, evading industries can also be brought to book and charged penalties; the maximum penalty that can be imposed is ten times the amount of evasion. The Technology Policy Implementation Committee, which was constituted to implement the Technology Policy Statement, recommended the creation of a Technology Development Fund. A Technology Development Board was constituted in September 1996 to "enable the placing of the proceeds of the R&D cess into the Fund for technology development and application. In order to encourage the industry to invest in R&D, annual awards are being given for achieving 'excellence in in-house R&D'. However, it is noticed that the amount spent on R&D as a Percentage of turnover among these winners had in most cases decreased and in some cases it is seen that though the percentage decreased initially it recovered later.

R&D activity in the country suffered to an extent due to the bureaucratisation of science. This lead to a state of affairs where some scientists donned the mantle of bureaucrats more than they functioned as leaders of science, and, hence, failed to generate enthusiasm among their junior peers. Moreover, the interaction between the universities and research

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40 DST, An Approach to a Perspective Plan for 2001
41 DST, Annual Report, 1989-90, n. 16, p.40. To start with the Fund was created with a sum of Rs. fifty lakhs
42 B. S. Raghavan, "S&T Policy Planning: Charting a New Course", The Hindu,
Addressing the Platinum Jubilee Session of the Indian Science Congress, one renowned scientist remarked that scientists themselves were found to be less motivated and, hence, were notable were not able to enthuse the younger generation. Therefore, the scientists shall have to shoulder the responsibility of 'providing the right atmosphere' and set an example in promoting excellence.

5. India Science Report 2005

Indian National Science Academy (INSA) commissioned a study to the National Council of Applied Economic Research (NCAER) to bring out the first India Science Report (ISR). ISR is an ambitious project that is intended not as an event but as a process, of which this first report is the beginning. Given the potentially vast canvas of issues that could be addressed by the first ISR, and limited time and resources, it was only inevitable that prioritisation of issues and topics would be needed.

While concerns have been expressed about falling science enrolment in the country, the report shows that the proportion of those enrolled in science courses has gone up from 28.8% of the population in 1995–96 to 34.6% in 2003–04. And within this, the proportion of those doing engineering has almost doubled, from 6.0% of the population studying at the graduate-plus level in 1995–96 to 11.2% in 2003–04. Indeed, engineering education shows the highest growth, from 8.2% per annum in 1995–2000 to 21.9% in 2000–04. Given their share in both the stock (23.1%) as well as in enrolment (33.4%), science stream students are adequately represented in most types of jobs.

This study also gives clear indications that the country's scientific stock is rising. Among the working population, the share of those who have a scientific qualification and are employed in an S&T activity, also called 'Core' HRST, has risen from 1.1% in 1981 to 1.6% in 1991 and further to 3.9% in 2004. Between 1991 and 2004 it grew by 9.3% annually against 5.7% from 1981 to 1991. The proportion of the population with a 10th (high school) and 12th (higher secondary) degree has increased significantly, from 8.2% in 1991 to 23% in 2004. Those with graduate degrees and above have risen from 2.4% of the population in 1991 to around 4.5% today. Students at lower classes have shown interest in science education — 60% of the students at the class 6th to 8th level said they wanted to pursue science education (pure science, engineering or medicine) as compared to 57% students in classes 11 and 12. Over 40% of the students, whether in classes 6 to 8 or 11 and 12, wanted to become engineers or doctors.

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43 C. N. R. Rao, "Frontiers of science and Technology: The Indian Context", General Presidential Address, 75th Science Congress, Pune, January 1988
Despite the low levels of literacy and spread of higher education, India doesn't fare too badly vis-a-vis high-income countries like the US. India scores lower than the US on attitudes towards science and technology, but not much lower. Seventy-seven per cent Indians feel S&T makes our lives healthier and easier as compared to 86% for the US. India compares unfavourably with the US on parameters like the proportion of its population that understands certain scientific concepts, such as, are electrons smaller than atoms, or whether the centre of the earth is hot; it does reasonably well given its relatively lower income and literacy levels. However, when it comes to issues like 'attentive' public (that is, the part of the public that is not only interested in certain issues but also follows up with regular reading of newspapers/magazines), India scores much higher than the US. Close to 19% of India's population can be considered attentive compared to fewer than ten per cent for the US. While the figure is 23% for India versus 6% for the US in the case of agriculture and farming, it is 18% (US) versus 12% (India) for economy and business areas.

It is also a good sign that most Indians have faith in science, as the study found, and feel that S&T can contribute to education, agriculture, economic growth and in general making their lives better. Such faith in science and technology gives the hope that the country's populace is ready to adapt to new technologies. This fact augurs well for the country as it prepares for a technological push into the future. At the same time, there is a need to avoid complacency and urgently address several areas of concern emerging in the findings of this report. For instance, in the study, about a third of the students said they did not study science as they did not feel motivated enough. This is where the role of science teachers becomes crucial. Since every generation of top quality scientific manpower starts at the school level, a lot also depends on the way science is taught at school levels.

The study found that while close to two thirds of the students in classes six to eight are satisfied with the quality of science teaching, this falls to just 40% in classes 11 and 12, clearly indicating a lack of availability of good and motivated teachers at higher levels. Teaching of computer science among other courses is considerably discouraging with just 15% of the students in government schools and 23% in private schools satisfied with teaching.

The findings also indicate that the initial urge to study science cuts across all sections of the society. However, for the sections in the lower socio-economic stratum, this does not often translate into fact at later stages due to several factors such as lack of affordability, lack of infrastructure, paucity of information about scope and future opportunities. The report
found that those in rural areas tend to go in more for arts than those living in urban areas. This could be due to a paucity of trained science teachers in rural areas, and hence, needs to be attended to. This is because the rural areas of the country still hold immense potential to add to the growing stock of scientific manpower in the days to come.

The report also points to the imbalance in terms of educational institutions in various states of the country. Such a situation leads to migration of students for various specific courses. This makes education costlier and also inequitable—those who can afford it only can go for it. Is this an optimal model for the educational setup in a country like India? This needs to be looked into.

Overall, the report clearly indicates that science education needs to be strengthened in terms of methods of teaching, teacher quality, and infrastructure. This observation has been found valid for all regions of the country. Although it is a good sign that the scientific stock is rising, is this scientific stock sufficient to meet the requirements in various priority areas, or is there an imbalance? The report finds that despite being a predominantly agricultural economy, not many are taking interest in pursuing agricultural education. The same is true for health education as well. The study found a drop in the enrolment in medical courses. Such trends need to be carefully monitored and corrective steps initiated.

The report also finds that of the total educated population, as we move towards higher education, the share of unemployed science literates increases significantly. For instance, of the postgraduates who are unemployed, about 63% have studied science. This is also true in the case of science diploma holders: 53% unemployed belong to the science stream. The report also finds that almost 30% of those who have finished at least their 12th class degree in science are not working, being either unemployed or housewives. It is the same with a fifth of the total science graduates and almost 14% in the case of Ph.Ds. For those who have passed their class 12 examinations with science, the figure is over 37%. There is a need to carefully examine this scenario and ensure that science literates are gainfully employed and contribute to the scientific development of the country.

Another important point the report makes is that over 44% of S&T information in the United States is obtained from the Internet as compared to 0.2 per cent in India. There is a vast potential still waiting to be tapped in India. Modern channels of information need to be harnessed to the fullest potential. ICT penetration is an issue that needs to be looked into to maximize the scientific returns from the vast cyber source of knowledge. There is also perhaps a need to ensure greater penetrability of Internet and other ICT tools at the school
level as also in rural and remote areas so that access to reliable and updated information is considerably improved. It needs to be realized that meaningful policies cannot be formulated in the absence of authentic data. Therefore, the necessity of collecting, collating, and analyzing reliable data to arrive at meaningful conclusions cannot be overemphasized. The National Science Survey–2004 was the first such attempt in this direction. However, much still needs to be done. There are several critical areas of national importance that have not been objectively addressed due to either incomplete or out-dated data or even due to non-existence of reliable data/information in a few cases.


The Prime Minister Dr. Manmohan Singh, unveiled the Science, Technology and Innovation Policy (STI) 2013 on January 3, 2013. The STI Policy seeks to send a signal to the Indian scientific community, both in the private and public domain, that science, technology and innovation should focus on faster, sustainable and inclusive development of the people. The policy seeks to focus on both STI for people and people for STI. It aims to bring all the benefits of Science, Technology & Innovation to the national development and sustainable and more inclusive growth. It seeks the right sizing of the gross expenditure on research and development by encouraging and incentivizing private sector participation in R & D, technology and innovation activities.

The policy also seeks to trigger an ecosystem for innovative abilities to flourish by leveraging partnerships among diverse stakeholders and by encouraging and facilitating enterprises to invest in innovations. It also seeks to bring in mechanisms for achieving gender parity in STI activities and gaining global competitiveness in select technological areas through international cooperation and alliances. The policy goal is to accelerate the pace of discovery, diffusion and delivery of science led solutions for serving the aspirational goals of India for faster, sustainable and inclusive growth. A Strong and viable Science, Research and Innovation system for High Technology led path for India (SRISHTI) are the goal for the STI policy.

The Key features of the STI policy 2013 are

- Promoting the spread of scientific temper amongst all sections of society
- Enhancing skills for applications of science among the young from all social sectors.
• Making careers in science, research and innovation attractive enough for talented and bright minds.

• Establishing world class infrastructure for R&D for gaining global leadership in some select frontier areas of science.

• Positioning India among the top five global scientific powers by 2020(by increasing the share of global scientific publications from 3.5% to over 7% and quadrupling the number of papers in top 1% journals from the current levels).

• Linking contributions of Science Research and innovation system with the inclusive economic growth agenda and combining priorities of excellence and relevance.

• Creating an environment for enhanced private sector participation in R & D.

• Enabling conversion of R & D output with societal and commercial applications by replicating hitherto successful models, as well as establishing of new PPP structures.

• Seeking S&T based high risk innovation through new mechanisms.

• Fostering resource optimized cost-effective innovation across size and technology domains

• Triggering in the mindset& value systems to recognize respect and reward performances which create wealth from S&T derived knowledge.

• Creating a robust national innovation system

Aspirations of the policy
The main aspirational elements of the STI policy are:

a. Raising Gross Expenditure in Research and Development (GERD) to 2% from the present 1% of the GDP in this decade by encouraging enhanced private sector contribution.

b. Increasing the number of Full Time Equivalent (FTE) of R&D personnel in India by at least 66% of the present strength in 5 years.

c. Increasing accessibility, availability and affordability of innovations, especially for women, differently-abled and disadvantaged sections of society.

Cyber Terrorism and National Cyber security Policy 2013
Cyber terrorism

As the Nation became successful in unearthing terrorist networks involved in the recently carried out terror attacks, the most outstanding feature was the use of the tools of the information age like emails, cell phones, satellite phones etc to stay connected. The worrying aspect was the use of modern gadgets bringing out that the terrorist is not only obsessed with IEDs and AK-47 but has also mastered the use of laptops and tablet PCs to give finesse to his nefarious designs. As terrorist organizations realize its capability and potential for disruptive efforts at lower costs they will become more and more technology savvy and their strategies and tactics will have a technological orientation. Cyber terrorism is the convergence of terrorism and cyber space. It is generally understood to mean unlawful attacks and threats of attacks against computers, networks, and information stored therein when done to intimidate or coerce a government or its people in furtherance of political or social objectives, Further, to qualify as cyber terrorism, an attack should result in violence against persons or property or at least cause enough harm to generate fear, Attacks that lead to death or bodily injury, explosions, plane crashes, water contamination or severe economic loss would be examples. Serious attacks against critical infrastructures could be acts of cyber terrorism depending upon their impact. Attacks that disrupt non essential services or that are mainly a costly nuisance would not.

Methods of Attacks

The most popular weapon in cyber terrorism is the use of computer viruses and worms. That is why in some cases of cyber terrorism is also called 'computer terrorism'. The attacks or methods on the computer infrastructure can be classified into three different categories.

a. **Physical Attack:** - The computer infrastructure is damaged by using conventional methods like bombs, fire etc.

b. **Syntactic Attack:** - The computer infrastructure is damaged by modifying the logic of the system in order to introduce delay or make the system unpredictable. Computer viruses and Trojans are used in this type of attack.

c. **Semantic Attack:** - This is more treacherous as it exploits the confidence of the user in the system. During the attack the information keyed in the system during entering and exiting the system is modified without the users knowledge in order to induce errors.
Tools of Cyber Terrorism

a. **Hacking.** The most popular method used by a terrorist. It is a generic term used for any kind of unauthorized access to a computer or a network of computers. Some ingredient technologies like packet sniffing, tempest attack, password cracking and buffer outflow facilitates hacking.

b. **Trojans** Programmes which pretend to do one thing while actually they are meant for doing something different, like the wooden Trojan Horse of the 12th century BC.

c. **Computer Viruses.** It is a computer programme, which infects other computer, programmes by modifying them. They spread very fast.

d. **Computer Worms.** The term 'worm' in relation to computers is a self contained programme or a set of programmes that is able to spread functional copies of itself or its segments to other computer systems usually via network connections.

e. **E-Mail Related Crime.** Usually worms and viruses have to attach themselves to a host programme to be injected. Certain emails are used as host by viruses and worms. E-mails are also used for spreading disinformation, threats and defamatory stuff.

f. **Denial of Service** These attacks are aimed at denying authorized persons access to a computer or computer network.

g. **Cryptology.** Terrorists have started using encryption, high frequency encrypted voice/data links etc. It would be a Herculean task to decrypt the information terrorist is sending by using a 512 bit symmetric encryption.

Existing Counter Cyber Security Initiatives

a. **National Informatics Centre (NIC).** A premier organisation providing network backbone and e-governance support to the Central Government, State Governments, Union Territories, Districts and other Governments bodies. It provides wide range of information and communication technology services including nation wide communication Network for decentralized planning improvement in Government services and wider transparency of national and local governments.
b. **Indian Computer Emergency Response Team (Cert-In).** Cert-In is the most important constituent of India's cyber community. Its mandate states, ensure security of cyber space in the country by enhancing the security communications and information infrastructure, through proactive action and effective collaboration aimed at security incident prevention and response and security assurance.

c. **National Information Security Assurance Programme (NISAP).** This is for Government and critical infrastructures, Highlights are:-
   1. Government and critical infrastructures should have a security policy and create a point of contact
   2. Mandatory for organizations to implement security control and report any security incident to Cert-In
   3. Cert-In to create a panel of auditor for IT security. All organizations to be subject to a third party audit from this panel once a year.
   4. Cert-In to be reported about security compliance on periodic basis by the organizations

d. **Indo-US Cyber Security Forum (IUSCSF).** Under this forum (set up in 2001) high power delegations from both side met and several initiatives were announced.

Highlights are:-
   1. Setting up an India Information Sharing and Analysis Centre (ISAC) for better cooperation in anti hacking measures.
   2. Ongoing cooperation between India's Standardization Testing and Quality Certification (STQC) and the US National Institute of Standards and Technology (NIST) would be expanded to new areas.
   3. The R&D group will work on the hard problems of cyber security. Cyber forensics and anti spasm research
   4. Chalked the way for intensifying bilateral cooperation to control cyber crime between the two countries

**National Cyber Security Policy 2013**

National Cyber Security Policy is a policy framework by Department of Electronics and Information Technology, Ministry of Communication and Information Technology,
Government of India. It aims at protecting the public and private infrastructure from cyber attack. The policy also intends to safeguard "information, such as personal information (of web users), financial and banking information and sovereign data". This was particularly relevant in the wake of US National Security Agency (NSA) leaks that suggested the US government agencies are spying on Indian users, who have no legal or technical safeguards against it. Ministry of Communications and Information Technology (India) defines Cyberspace is a complex environment consisting of interactions between people, software services supported by worldwide distribution of information and communication technology.

**Objectives:** Ministry of Communications and Information Technology (India) define objectives as follows:

- To create a secure cyber ecosystem in the country, generate adequate trust and confidence in IT system and transactions in cyberspace and thereby enhance adoption of IT in all sectors of the economy.
- To create an assurance framework for design of security policies and promotion and enabling actions for compliance to global security standards and best practices by way of conformity assessment (Product, process, technology & people)
- To strengthen the Regulatory Framework for ensuring a secure cyber space ecosystem. To enhance and create National and Sectoral level 24X7 mechanism for obtaining strategic information regarding threats to ICT infrastructure, creating scenarios for response, resolution and crisis management through effective predictive, preventive, protective response and recovery actions
- To improve visibility of integrity of ICT products and services by establishing infrastructure for testing & validation of security of such product.
- To create workforce for 5,00,000 professionals skilled in next 5 years through capacity building skill development and training
- To provide fiscal benefit to businesses for adoption of standard security practices and processes
- To enable Protection of information while in process, handling, storage & transit so as to safeguard privacy of citizen's data and reducing economic losses due to cyber crime or data theft
- To enable effective prevention, investigation and prosecution of cybercrime and enhancement of law enforcement capabilities through appropriate legislative intervention