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DECLARATION

I declare that the dissertation entitled **"Indo-U.S. Cooperation in Science and Technology since 2001"** submitted by me for the award of the degree of **Master of Philosophy** of Jawaharlal Nehru University is my own work. The dissertation has not been submitted for any other degree of this University or any other University.

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CERTIFICATE

We recommend that this dissertation be placed before the examiners for evaluation.

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CONTENTS

Abbreviations

AAAS	American Association of Advancement of Science
ALH	Advance Light Helicopter
BXA	Bureau of Export Administration
CCL	Commerce Control List
COST	Committee Of Science and Technology
CMM	Capability Mature Model
CMU	Carnegie Mellon University
CNN	Cable and News Network
CSIR	Council of Scientific and Industrial Research
CTBT	Comprehensive Test Ban Treaty
CTP	Composite Theoretical Performance
DOC	Department of Commerce
DOAE	Department of Atomic Energy
DPPG	Defence Procurement and Production Group
DRDO	Defence Research and Development Organizations
EAR	Export Administration Revolution
EL	Entities List
FLS	Flight Control System
GATT	General Agreement on Tariff and Trade
Gbps	Gigabits per second
GE	General Electronics
HPC	High Performing Computer
HTCG	High Technology Cooperation Group
IAEA	International Atomic Energy Agency
ICAR	Indian Council of Agricultural Research
ICBM	Inter Continental Ballistic Missile
ICMR	Indian Council of Medical Research
ICRISAT	International Crop Research Institute for Semi Arid Tropics
IGMP	Integrated Guided Missile programme
IIT	India Institute of Technologies
IMD	Indian Meteorological Department
IMTP	International Military Training Programme
INSAT	Indian National Satellite
IPA	Indian Patent Act
IPR	Intellectual Property Rights
IPRA	India-Pakistan Relief Act
IRBM	Intermediate Range Ballistic Missile
ISRO	India Space Research Organization
ISTRAC	Indian Space Research Organization's Telemetry, Tracking and Command Network
LCA	Light Combat Aircraft
MIT	Massachusetts Institutes of Technology
MoU	Memorandum of Understanding
MTCR	Missile Technology Control Regime
MTOPS	Million Theoretical Operations per Seconds
NASA	National Aeronautics and Space Administration
NASSCOM	National Association of Software Companies
NIH	National Institute of Health
NNPA	Nuclear Non Proliferation Act
NPT	Non-Proliferation Treaty
NSG	Nuclear Supplier Groups
NSSP	Next Step in Strategic Partnership
ODM	Office of Defence Mobilization
OSTP	Office of Science and Technology Policy
PACT	Programme for Advancement of Commercial Technology
PSAC	President's Science Advisory Committee
SACC	Scientific Advisory Committee to the Cabinet
SITE	Satellite Instructional Television Experiment
STI	Science and Technological Initiatives
SVIL	Sankhya Bahini India limited
TIFR	Tata Institute of Fundamental Research
TRIMS	Trade Related Investment Measures
TRIPS	Trade Related Intellectual Property Rights
UGC	University Grant Commission
USAID	U.S. Agency for International Development
WMD	Weapons of Mass Destruction

PREFACE

In this age of science, the scientific and technological issues crossed the confinements of laboratories and woven into political, economic and social concerns of every nation. It has been a well established fact that the socio-economic development of a nation is very often hinges upon the degree of its scientific progress. Science and technology also plays a dominant role in shaping international relations and foreign affairs of states. This importance can be gleaned from science and technological developments potential to address the critical global challenges like national security, pollution, HIV/AIDS, etc. Technologically developed countries are extensively using technology as a major instrument of foreign policy in form of *cooperation* or *sanction* upon the dependent ones. The present piece of work focuses on the scientific and technological co-operation in Indo-US relations since 2001 as strategic alliance between these two large democracies is considered crucial for global peace and stability. Further this long standing and successful relation can be considered a model to study the intricacies of *technology transfer* between countries.

Chapter-I is introductory in nature which deals with the complexity lies in understanding the existing scientific and technological policies in both the countries. It also emphasizes how it plays a decisive role in making of the foreign policy.

Chapter-II, gives a detailed historical account of the relationship between India and the United States over five decades of time period, starting from 1950s. It also analyses the current trends of the relationship reflected through alliance in the field of Information and Communication Technology and Bio-Technology.

Chapter-III, illustrates about changing nature of the cooperation in post 9/11 period. It mentions how the sanctions were neutralized and their implications on the relations between the two countries. Chapter-IV is the crux of our study which depicts about the developments that occurred in the science and technology cooperation after 2001. Further it describes about the formation and functioning of different initiatives like *High Technology cooperation Group* (HTCG) and *Next Step in Strategic Partnership* (NSSP) that are now considered as symbols of enhanced strategic cooperation.

The final chapter concludes with summarizing the whole study vis-à-vis Indo-US scientific and technological cooperation with critical analyses from the perspective of both the countries.

INTRODUCTION

Science has profoundly influenced modern Civilization. It has provided remarkable insights into the world we live in and glimpses of the large Universe around us. Major scientific revolutions of the twentieth century have caused several technological innovations that have led to new thinking in almost all fields such as Agriculture, Communication, Energy and so on .However Science is no longer considered the concern of scientists alone. It is deeply involved in social, economic, and political development of countries. It also affects the developments and is in turn affected by them. Governments realized the critical role of science and technology could play in achieving a wide range of objectives. They are now taking the necessary steps to realize the possibilities engendered by scientific developments. Further, they have begun to take a more active part in sponsoring, organizing and directing scientific research as they perceive that the market mechanisms, left to themselves would not generate the required results. Science and technology is an integral part of governments and they have duly recognized the key role of technology in aiding development and providing security. For instance According to a report of US National Academies, technological advances have been responsible for 85 percent of the growth of American per-capita income over the past century. Science and technology has also led it to become an important portfolio of the government especially given one vital role they play in the security of countries. two sides of the same coin. As pointed out by the Preamble of Science and Technology policy 2001 of Government of India, unfettered and creative science has invariably given birth to innovative technologies. In the current era, science and technology hold the key to prosperity.

Since the end of Second World War, the developments which have taken place in the field of Science and Technology were directed by governments towards the goal of development and security. Consequently, the interactions and the impact of these developments at various levels of governments were analyzed to arrive at conclusions, and to guide future developments. For instance, one could see on the one hand the development of organizational pattern, of investment policies and of effort to coordinate the existing machinery to evolve a policy of scientific and technological *"research"* in the advanced countries. On the other hand, the endeavor of the developing countries, under the impact of international developments was to create a base for science and technology and channel its growth according to a well defined *policy*. The role of Science and Technology are central to provide the basic needs and raise the quality of life, create wealth and be globally competitive in an increasingly digital world and to protect our environment and harness nature,. Such a policy, often referred to as science policy, became central part of a national plan as in India. The goals emphasized were often self-reliance and sustainable and equitable development.

Science policy included a government course of action intended to support, apply, or regulate scientific knowledge or technological innovation. Support included direct funding of basic research, subsidies, such as tax credits for research and development, and other indirect programmes such as financial assistance for education in science and technology. To elucidate, the government deliberately applied "Science Policy" when it turn to scientists and technicians for their expertise in solving public problems ranging from agriculture to ballistic missiles defence systems. When government trends equipments or services thereby affecting the pace and directions of R&D it supports growth of science and technology which can be both positive (i.e. promotional, as when environmental regulation require advances in anti- pollution technology) and negative (as when policies restrict the type of genetic research experiments that scientists can perform). [1]

In practice, science and technology policies frequently include all 3 types of action (i.e. governmental support, apply and regulation). After all, the formation of policies to support or regulate science and technology depend on application of knowledge. The use of knowledge in policy making frequently includes no explicit statements of intent to support or regulate research, but the application of science and technology in policy often has at least the indirect effect of making someone wants to know more often because knowledge was missing, uncertain or misused.

As definition of science and technology policy could include realms of energy, health, defense, transportation, housing and education, one may ask whether it is a distinct type of public policy. Science and Technology policy covers a wide range of problems covering different areas. What makes policy making so difficult in government's handling of science and technology is the institutional setting within which it works. Science and technology, while undeniably a governmental responsibility, is not a unitary function; rather it is pluralistic. Science and technology are not so much national missions as their sub-missions, fused to the particular measure purposes of Administrative Departments and Agencies. They are, in short, means for achievement of larger ends i.e. the promotion of commerce and industry, the development of agriculture productivity, the pursuit of health, welfare and education, the maintenance of military superiority, and so on. Science and technology therefore are ladled out of many pots, in each of which some thing distinct has been

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[1] Richard Barke, "Understanding Science and Technology", *Science Technology and Public policy* (New Delhi: Affiliated East West Press Pvt. Ltd, 1986), p.12.

brewed, yet are unrecognizable as a coherent and balance synthesis to which the term 'policy' can be applied.

I. MAJOR ASPECTS OF SCIENCE POLICY:

(i) Carrying out surveys and studies for evolving science policies.

(ii) Planning for science and technology.

(iii) National science policy.

(iv) Budgeting for science.

(v) Implementing agencies.

(vi) Coordination and evaluation of research, and

(vii) International collaboration.

Not only it has a vital role in the development of a country and shaping the domestic policies, science and technology is also an important component in every country's foreign policy, which is increasingly critical to address the global challenges of the twenty first century whether the issue of terrorism , homeland security, sustainable development, HIV/AIDS or the environment. Science, Technology and Foreign policy form an essential triangle of policy making. Major political decisions regarding international balance of power, nuclear energy, exploration of space and host of other crucial programmes cannot be made independent of what science and technology hold for both developed and developing nations. These decisions in turn contribute towards shaping national policies and thus, affect the nature of growth of science in different context. The inseparable relationship between science and politics has, therefore, vastly expanded the scope of politics of science.

In international relations theory, the scientific and technological advancement of a nation is regarded as an important attribute of its national power. [2] It is also considered important for economic and military development. As a result, it had a direct relationship with domestic and foreign policies. Science and technology helps in developing infrastructure and industries in the domestic sphere. This same know how also has military applications for the development of sophisticated armaments. Science and technology could also be used in the international sphere as a means to win friends and warn adversaries.

In the context of the US, science and technology had considerable effect on its foreign policy and diplomatic relations ever since the country attained a status as a superpower. Though the instrument of technology transfers it attempted to attain its goals in international politics and economic relations. During the days of Cold War, the US initiated the containment policy to check the Soviet influences in various parts of the world. But, as the Soviets were also trying to catch up with the US in technology, it began to follow a hard line approach in this aspect too. The US was prepared to have economic relation with the Soviet but denied any technological cooperation.[3] However, after the disintegration of Soviet Russia and the end of the Cold War era the situation changed. New threats like terrorism and HIV/AIDS have loomed up demanding technologically sophisticated solutions. Consequently, one of the major agenda of the US foreign policy is to restrict the technology flow to terrorist networks and nations who are suspected of having links with them.

US-India relations in the field of science and technology is one of the oldest, most extensive and successful bi- lateral cooperation which is about five decades old. Starting with collaboration in agriculture in 1980s, the 60's saw

[2] Norman A. Graebner, *Cold War Diplomacy-American Foreign Policy, 1945-1975*, (New York: D. Van Nostrand Co. Ltd, 1977), p.7.
[3] Ibid., p.18.

expansion in other fields of science and education such as establishment of IITs in Kanpur, NCERT in Delhi among others. SITE program in the 70s saw close cooperation between NASA and ISRO. The two countries established Science and Technology Sub Commission in 1975 which resulted in large number of research program and workshops. In the era of Cold War, the relationship was characterized by highs and lows due to American containment policy or India's Non-alignment ideology. Nevertheless, scientifically and technologically, India had always remained a key state for America .several reasons can be attributed for this. Some analysts have pointed to its geo-political position, its vast intellectual human resources, its emerging economy or more recently becoming a strategic partner in the war against terrorism, as an explanation.

American technological cooperation with India started with "Point-Four Programme" announced by President Truman in 1950.This was enunciated for providing US technical assistance to developing countries like India .But the onset of Cold War and the shimmering East-West tension made the US cautious in its approach towards delivery of such assistance. Moreover, India started to develop extensive economic and military relations with Soviet Union. This undeclared yet extensive tilt of India toward the Soviet Union had a considerable impact on Indo-US relations in general and technological cooperation in particular.

During the Cold War, the relations between the US and India in the field of technology could be viewed from both the political and strategic perspectives. During this period the US followed strict policies pertaining to technology transfer to India. However, the final decades of the Cold War, namely the 80s, proved to be an exception to that policy proposition. In 1982, India and the US signed the Science and Technology Initiative (STI). This extensive programme marked a watershed in their bilateral relations especially on the technology front.

After the Cold War, the Indo-US science and technological relation gained momentum due to vanishing of constraints of global bi-polarity. Many institutional and organizational settings such as Indo-US Scientific Forum and Cooperative Programme like Next Step in Strategic Cooperation (NSSP) were started to modernize the cooperation. Recently as India is pioneered in the field of software, biotechnology and space, both the countries are trying to exploit each others capabilities fully.

Hence , a study of the scientific and technological relations between India and the US from a historical perspective not only throws a light on how science and technology acted as an important factor of foreign policy of nations but it also enables an analysis of the US technology transfer diplomacy during different eras.

CHAPTER-1

SCIENCE AND TECHNOLOGY POLICY IN INDIA AND THE US.

In advanced countries, in addition to the responsibilities given to national organizations, special units, centers, and institutes have been created, besides sponsoring research in universities and other institutes, to study specific problems regarding scientific research and policy making. As a result of these studies, considerable data have now accumulated to throw light on science policy and how it helps in the decision making. However in case of India we can say that, a study to develop a definite and articulated *science policy* is yet to be organized.

I. ASPECTS OF SCIENCE POLICY IN INDIA

The role of science in providing means of progress and development was realized by the leaders of the country much before the country attained the independence. In 1939, the Indian National Congress appointed a National Planning Committee and leading scientists to participate in the formulation of plans of economic development and social betterment.[1] A study group dealing with the problems of general education, technical education and scientific research was constituted. [2] This group besides other suggestions, recommended that the programmes of industrial and educational development should be closely linked with the programmes of scientific research. Further, it emphasized that various sectors of the latter should be closely coordinated. In addition to the latter, Prime Minister Jawaharlal Nehru also emphasized the importance of scientific outlook and the need for utilization of science in the solution of problems facing the country. In a famous statement he pointed out:

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[1] C.N.R Rao, "Challenges in Indian Science and Technology" in S.C Prakash and G.P Phondke(eds) *Science Technology and Industrial Development in India,(* New Delhi: Wiely Eastern Publication , 1995) Pp.2-3.

[2] B.Srinivasn. " Machinery for Formulation and Overseeing of Implementation of National Science Policy", *Indian Journal of Public Administration* , (July-September 1969),Vol. 15, No.3, Pp.4715-448

"My interest largely consists in trying to make the Indian people and even the Government of India conscious of scientific temper... ....I myself am convinced that there is going to be no very great progress in science or in other ways unless certain fundamental changes take place in the social structure".[3]

After attaining independence, India deliberately put itself to the task of transforming its social and economic structure through the process of planning. It was envisaged that planning was the only way through which the country could be put on the road to self-sustained growth, after centuries of stagnation. The government after independence took an active role in encouraging research in universities and established a chain of research laboratories. The significance attached to scientific research in independent India could be judged from the creation of ministries of science and technology directly under the Prime Minister.

I.a. *Evolution of Science Policy in India:*

India was the first country in the world to create a Ministry of Scientific Research and Natural Resources, the purpose of which was to organize and direct scientific research for national development. The enthusiasms with which the ministry pursued the tasks of promotion of science and technology was borne out by the creation of agencies for research in specialized areas .All five year plan documents had, also, emphasized the role of Science and Technology in economic and social transformation. However, the most important step was the adoption of the Scientific Policy Resolution by the parliament in 1958.

[3] Jawaharlal Nehru, "Science in the Service of the Nation", Proceedings of the 34th Indian Science Congress, Delhi, Part-II- Presidential Address (Indian Science Congress Association, Calcutta, 1974), Pp.1-3.

I.b.Scientific Policy Resolution-1958:

The spirit and enthusiasm of the people of India for scientific pursuit received great stimulus when a very comprehensive resolution, known as the Scientific Policy Resolution was brought forth in Parliament embodying the considered science policy of Indian Government.[4]

This resolution had brought out: (I) the various ways and means by which science and technology could promote the economic development in the country; (ii) the steps to promote the scientific research within the country through the creation of proper environment; and (iii) the decision of the government of India to associate scientists with the formulation of policies.

This was a bold decision which resulted in a formal policy for science and its development and, the inclusion of 'science' in policy making for other social and economic policies.

The main objectives and aims of the scientific policy resolution were:[5]

(i) To foster, promote and sustain, by all appropriate means, the cultivation of science and scientific research in all its aspects-pure, applied and educational;

(ii) To ensure an adequate supply, within the country, of research scientists of the highest quality, and to recognize their work as an important component of the strength of the nation;

(iii) To ensure that the creative talent of men and women is encouraged and finds full scope in scientific activity:

(iv)To encourage individual initiative for the acquisition and dissemination of knowledge in an atmosphere of academic freedom; and

[4] Government of India (1958), *Scientific Policy Resolution,* 4 March, 1958. No.131/C/57, Ministry of Scientific Research and Cultural Affairs, New Delhi.

[5] B.N Prasad, "Science in India" in *Shaping of Indian Science: Indian Science Congress Association, Presidential Addresses,* (Hyderabad: University Press, 1948-1981) Vol: II, Pp.898-899.

(v) In general, to ensure for the people of the country all the benefits that can accrue from the acquisition and application of scientific knowledge.

I.c. *Machinery Responsible for Coordination and Science Policy Formulation*

An important aspect of science policy was concerned with the promotion of coordination among the various science councils, commissions, autonomous agencies, institutions under different ministries in India. This problem of effective coordination of scientific acclivities has been receiving the attention of Government of India since independence.

The first step in this direction was the setting up of an Advisory Committee for coordinating scientific research under the chairmanship of the then Prime Minister, Shri Jawaharlal Nehru, with the following terms of reference:[6]-

(I) To coordinate the scientific activities of various ministries of the government of India.

(ii) To devise the ways and means to encourage team work.

(iii) To avoid as far as possible duplication.

This committee operated at the highest level of political decision making in the country. Since the political leadership had very little acquaintance with S & T and the way it operated and interacted the committee could hardly play an effective role, and left it to the leadership.

Consequently, the basic blue print of the scientific structure created in expanding scientific and technical education at all levels. To remedy the

[6] National Committee on Science and Technology (1953-54). *Research and Development Statistics*, (New Delhi, Department of Science and technology , India) p.3.

deficiencies of this committee another committee consisting of eminent scientists and under the chairmanship of Dr. H.J Bhaba was established in 1956. This committee was known as the Scientific Advisory Committee to the Cabinet (SACC). The terms of reference of SACC were: [7]

I. to advise the cabinet:

(A) In the formulation and implementation of the government's science policy.

(B) On scientific and technical cooperation with other countries and with international scientific and technical organizations.

II. To place before the Cabinet such proposal and advice as may improve and develop scientific and technical work in the country. The membership of this committee included cabinet secretary, and the heads of Council of Scientific and Industrial Research (CSIR), Indian Council of Agricultural Research (ICAR), Indian Council of Medical Research (ICMR), University Grant Commission (UGC), Atomic Energy Commission (AEC) and Scientific Advisor to the Minister of Defence. Its requirements were met by the cabinet secretariat.

SACC worked for about ten years. Most of its work was carried out secretly and their deliberations were not publicly discussed. Thus, the scientific community, at large, was kept out of the decision making process. Secondly, the SACC had no initiative of its own. Thirdly, after the death of Dr. Bhaba, the Cabinet Secretary became its chairman and its style of functioning became more bureaucratic. Lastly as the analysis of terms of reference suggested, SACC had no mandate to coordinate the total scientific developments in the country or to draw up a comprehensive *science policy* for the nation as a whole. Thus, during its entire life span probably, SACC might have taken some important decisions, but most of them might have been sectoral and uncoordinated.

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[7] CSIR (1965). *The CSIR Saga: A Concise History of Its Evolution*. Vol.1(up to 1965),p.24.

In 1968, the SACC was found to be inadequate to meet the growing task of developing a comprehensive science and technology policy and integrate it with other social and economic policies. It was replaced by the Committee of Science and Technology (COST). The committee was to advise the government on: [8]

A. the formulation and implementation of government's policy on science and technology and determination of national priorities in these areas;
B. the pace of the development of scientific research and technology, suggest measures for correcting imbalances whenever necessary;
C. the coordination, cooperation and communication between ministries of government and semi-governmental and non-governmental Scientific and Technological institutions in the countries;
D. Scientific and technological cooperation with international Science and Technological organizations ; and
E. Any other matter that may refer to it by the government.

In contrast to SACC, the COST had its own secretariat and its membership consisted of the Cabinet Secretary, heads of various R&D establishments, Chairman of UGC, an economist, a few independent scientists and industrialists.

To sum up, it could be said that the COST had set the basis for preparation of comprehensive science policy in the country.

However, the COST was replaced by the National Committee on Science and Technology (NCST) in November; 1971. The NCST has the following functions:[9]

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[8] Committee on Science and Technology (1970) *Proceedings of the Third National Conference of Scientists,techonologists and Educationists*, New Delhi, p.47.
[9] National Committee on Science and Technology (1975), *Research and Development Statistics*, New Delhi, India, p.5

(a) The preparation, evolution and updating of national scientific and technological plans, both five year and perspective plans in close cooperation with the Planning Commission. These plans would be intimately related, in terms of relative priorities and the allocation of resources to the national plans;

(b) The pattern and mode of development of Science and Technology, including measures for correcting imbalances;

(c) The attainment of scientific and technological self-reliance and the full utilization of the nation's scientific ,technological and industrial resources ;

(d) Coordination, cooperation and communication between ministries of government and between governmental , semi-governmental and non-governmental scientific and technological institutions ;

(e) International scientific and technological matters including cooperation with other countries and with international organizations.

The minister for industrial development, who was also looking after the affairs of CSIR- the premier research body for civil research in India-was made the Chairman of the NCST.

After some time a new experiment was tried with the NCST. It was put under the chairmanship of the Deputy Chairman, Planning Commission. The objective was that, this arrangement would bring about greater coherence between plans for economic development and science and technology plans. There would be correspondence and balancing between the two plans and thus science policy would reflect the social and economic priorities. The major contribution of the NCST was formulation of a comprehensive science and technology plan. After the scientific policy resolution of 1958, this was the major government document, which listed out, the objective of the science and technology policy, the major areas of thrusts and the role of science and technology in fighting poverty and backwardness. The document was presented in two volumes; first volume contained a statement of policy issues and second volume had dealt with the concrete programmes.

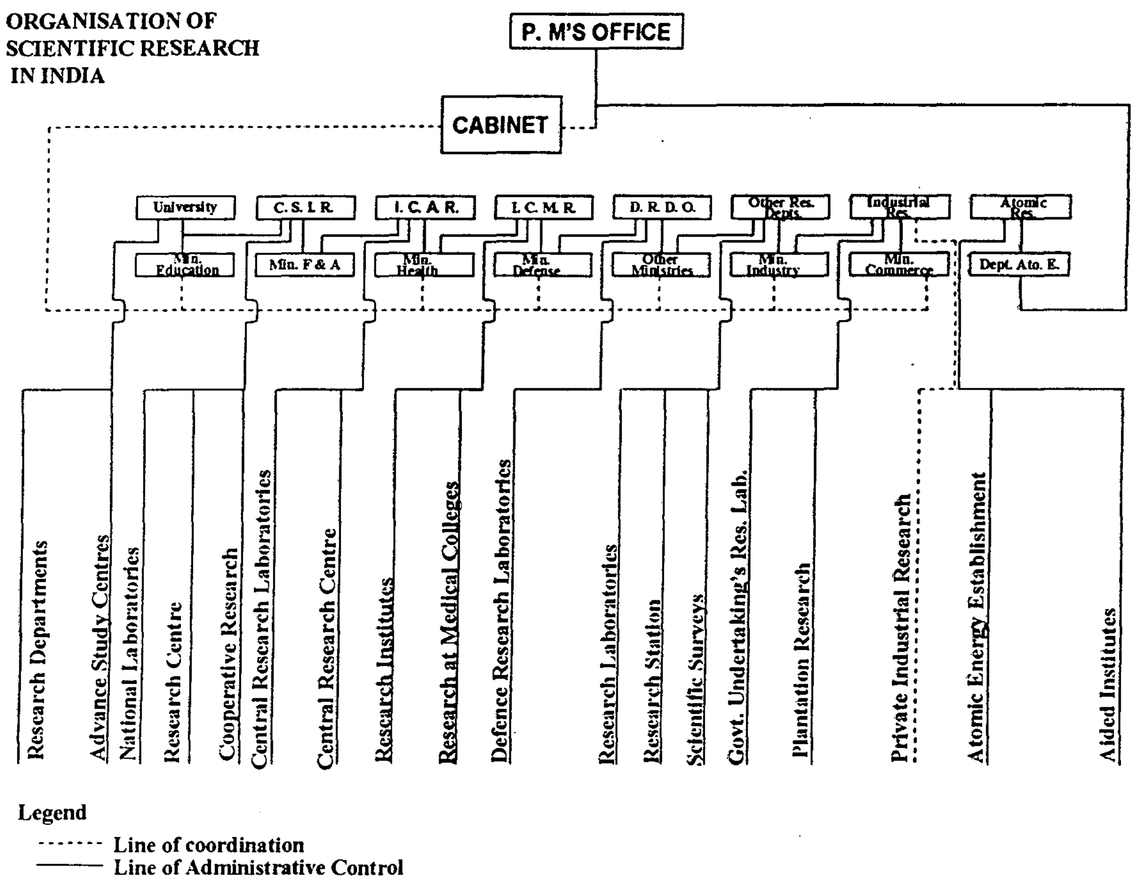
The NCST prepared reports in various fields of scientific and technological research dealing with Textiles, Khadi and Village Industries, Energy Development, Heavy Engineering and Machine Tools, Housing and Construction.

I.d. *Linkage of Science Policy Making Body with the Implementing Agency:*

It has also been realized that in spite of apex bodies like the NCST and the COST, the of science and technology policy making, continued to remain sectoral.[10] Each organization responsible for a sector of science and technology has been having its own micro-science policy. Therefore, to have a clear picture of science policy formulation, we must understand the links between the apex body at the national level and the sectoral agencies. This would, also, help appreciate the difficulties in evolving a comprehensive national science policy, however desirable it may be. Secondly, it would enable to understand the diverse forces at work in evolving a national science policy.

[10] G.P Kane, "Policy for industries" in Chanchal Shankar(eds), *Science in India's Future*, (New Delhi: Vikas Publishing House,1986),Pp.12-13.

Before one can discuss the linkage between science and technology policy making body and various implementing agencies, it is necessary to have an idea of the organizations of science and technology in India. Here follows a diagrammatic representation of the prevailing organizations of science and technology in India:



As evident from the chart, the organizations of scientific and technological research can be grouped in to following six categories:

(I) Departments mainly looking after scientific and technological institutions:

a. Department of Atomic Energy (DAE)

b. Department of Science and Technology (DST)

c. Department of Electronics, and

d. Department of Space.

(II) Councils like CSIR, ICAR, and ICMR.

(III) University research supported by UGC and other agencies

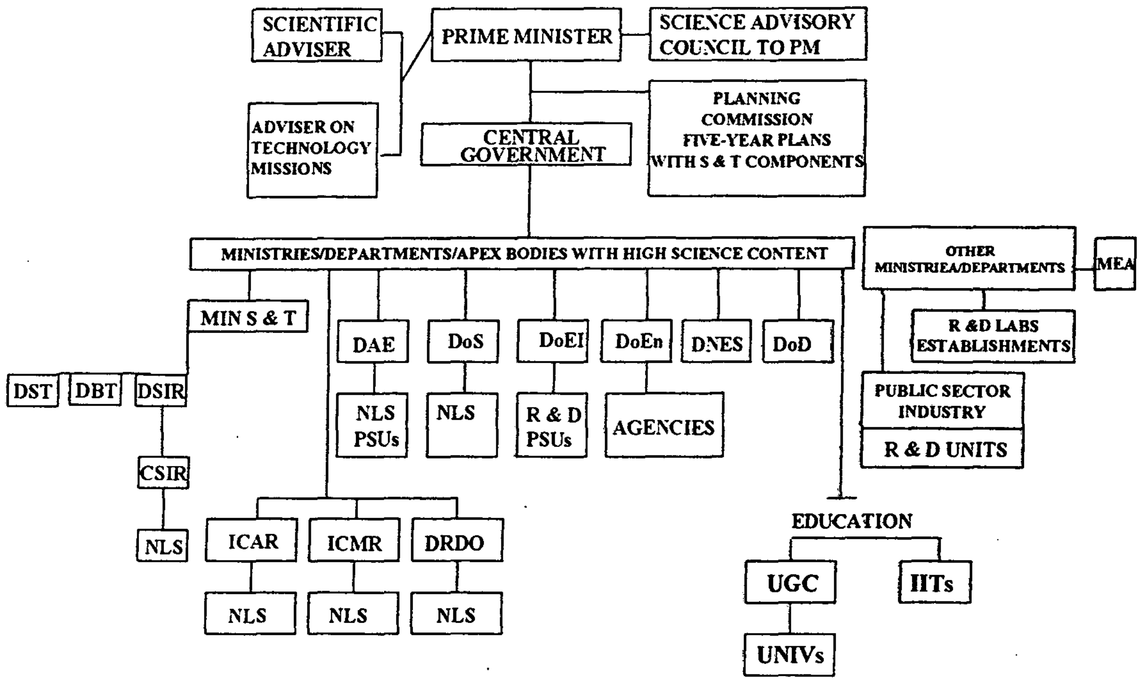
(IV) Departmental laboratories directly under various ministries or other departments.

(V) Defence Research and Development Organization (DRDO)

(VI) Research supported by Industries and Endowments.

There are no formal or substantive linkage between NCST and the implementing agencies, i.e. the research commissions, councils, departments and organizations. The connection is indirect through the membership of the NCST. All the heads of the major research organizations are ex-officio members of the NCST. The position of NCST is vague in the government hierarchy. In this regard the predecessors of the NCST, i.e. COST and SACC, were slightly in better position, as they were attached to cabinet secretariat and, hence, had directly linked with the cabinet. As a committee attached to one of the departments, it can not exercise any role over the other departments which, also, enjoy the equal autonomy. For an example, the Science and Technology Plan prepared by the NCST was, by and large, meant for the CSIR laboratories and surveys of the DST. The important sectors such as electronics, space, and atomic energy remained out side the purview of NCST. Similarly, agricultural sector is, also kept out of the Science and Technology plan. This is because the NCST has no mandate over other departments of the government. As stated earlier, various administrative experiments in linking the NCST to Ministry of Industrial Development first and then to planning Commission did not provide any effective linking mechanism.

SCIENCE AND TECHNOLOGY FRAMEWORK OF CENTRAL GOVERNMENT



NL-Network of labs
PSU-Public Sector Undertakings
UNIVs--Universities

Lastly, on the question of the role of unattached independent national apex body as an agency to formulate plans and policies for total science and technology areas, the arguments in favour are based on the premise that an independent body with no vested interests can have an unbiased assessment of priorities. The priorities when recommended for implementation to the concerned organization may come in conflict with the hierarchy of priorities of the organization. In that case there would arise a need for adjudication between the NCST and the implementing agency. This entails giving executive powers to the NCST and the implementing agency making NCST a super-power-department.

There is no ready-made solution to this problem till now in India. For free market economies, this is a major problem.

I.e. *Impact of Five-Year plans on Science Policy in India:*

Five year plan documents constitute an important source to assess the elements of national science policy. Since Prime Minister Nehru was himself interested in the development of science, he laid emphasis on utilizing scientific discoveries for rapid industrialization of the country.[11] Decisions on the establishment of scientific institutions and their funding were taken arbitrarily till 1955. The responsibility of planning commission in the area of scientific research was defined more clearly after 1959. However the Planning Commission did not evolve any mechanism to integrate the two aspects of development plans, i.e. economic and industrial plans, on the one side and science and technology plans, on the other. Secondly, in the initial plan periods, emphasis was given to build viable Science and Technology institutions in the country. In those periods of rapid growth of scientific institutions, attempts at coordination were meant only to allocate more resources to sectoral organizations for expansion and diversification. Thirdly, the initial plans of industrial development relied heavily on the imported know how and technology. This was because of compulsion of under development and legacy of long colonial rule. By the time a viable structure of science and technology was created, national apex bodies had been formed for formulating science policy in the country. Between the two national bodies i.e. the Planning Commission, and apex science bodies, as the COST/NCST, science and technology programmes are coordinated and integrated with national plans. The current science and technology of India announced in 2001 and in 2003, clearly laid out the policy

[11] Jawaharlal Nehru , *Discovery of India*, (Bombay: Asia Publishing House, 1972), Pp.395

objectives and the basic improvements for strengthening infrastructure in academic institutions.

II. SCIENCE POLICY IN USA:

A distinctive feature of American government since World War-II has been the emergence of "science policy "as a focus of thought and action. Before the war, numerous obstacles, institutional and traditional, worked against a significant role for science and technology in public affairs. First, the constitution has always restricted the powers of the federal government to minimum necessary functions, only two of which have a direct bearing on the mobilization, regulation, or coordination of scientific resources. Article 1, section 8 empowers congress "to promote the progress of science ... by securing to authors and inventors the exclusive rights to their respective writings and discoveries, ". The same article also entitles congress to prescribe uniform weights and measures, "a power that eventuated in the establishment of the national bureau of standards in 1901.

Almost from the beginning of the Republic, the federal government surveyed and mapped the land, collected customs, watched over public health, and pursued other technical activities in specialized agencies staffed with professionals from relevant scientific fields. Scientific activities were, however, usually not seen as matter of national importance to the great public issues of the day. In only a few instances, most notable perhaps being in supporting the growth of American agriculture.

Even as the assumptions underlying government activity began to change and the elements of a modern welfare state began to take shape, scientific research remained a peripheral activity. Care for the needy, shelter, universal education and literacy, health, and other aspects of social policy became objects of government action, but direct government support for science in the universities, or the direct linkage of research activities to the fulfillment of broad social goals, came more slowly.

Evidence shows that there was three main phases in the evolution of Science and Technology in the US. As the study points out, the first phase of science policy making lasted from about 1950 , when the post-war system was put in place , until the system became subject to increasing stresses and began to undergo a transformation about 1966 . A second phase ensued until the middle of the Carter administration, when the system entered a third, and current, phase.[12]

It is further argued that science policy devise the means to support basic research , to link applied research effectively to national priorities , to coordinate the jurisdictional issues that inevitably arise in the wake of scientific and technological advance , and to regulate a few obviously dangerous technologies, it also , promoting beneficial developments . Defense, space, and atomic energy issues dominated this phase.

Regulating dangerous side effects of technology became an urgent challenge. Such social priorities as preserving the environment and protecting consumers became important objectives. Critics assumed that technology could be easily redirected to serve more humane ends, and they sometimes presented their own versions of simple technological solutions to complex problems. The progression from basic research to practical application also proved less

[12] Bruce L. R Smith, "Science Policy in the American Context", in *American Science Policy Since World War II*, (Washington D.C: The Booking Institution, 1990), p.3.

automatic than previously supposed. More policy attention was required to move a discovery to commercialization of products.

Despite a vast outpouring of literature, in American context the core of "science policy "or "science affairs" has proved elusive. One typology pronounced the subject as ranging from "policy for science" to "science in policy".[13]

The Agencies or Line Departments such as Defense , Transportation , Agriculture , and Health and Human services pursue technological and research programs to advance public goals , while the staff units of the President and Congress fit those programs into the framework of Presidential and Congressional priorities. But they operate within a web of values, customs, and norms that give the whole process stability and orderliness. Hence, the field became a cluster of loosely related subspecialties.

In another way, science policy was perceived to be concerned with the promotion of scientific discovery and technological innovation, the regulation of potentially harmful side effects resulting from their application. The coordination of policies and programs within the government and in society to achieve the appropriate balance between nurture and resistant.[14] Typically promotion, regulation, and coordination are present in some combination in every government science and technology program.

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[13] Ibid. p.4.
[14] Harvey Brooks, " The Scientific Advisor" in Robert Gilpin and Christopher Wright (eds), *Scientists and National Policy Making* (Columbia University Press,1964), Pp.97-112

The business firm also uses its research department to invent new products, and the university laboratory seeks to advance itself through discovering new techniques or developing new fields of inquiry.

II.a. ***Elements of Science Policy:***

- Basic Research.
- Applied Research.
- Commercialization.
- Regulatory Behavior.
- International Issues.

The nation's science policy has been stated to being a mixture of different policies, programs, and institutional arrangements that have evolved to create and sustain basic research. It attempts to show how satisfactorily the system has worked to promote scientific and technological advances to achieve broad social goals and how scientific and technological research can become translated into new products and services. it also includes the aspect of Commercialization which involves a range of activities , some highly technical, as a scientific idea becomes embodied in production and distribution , enhancing economic growth , creating jobs, and keeping American industry competitive. The government's role has been significantly modified by the increasing importance of foreign trade and of international capital and technology flows. [15]

Scientific knowledge influences public policy on such as arms control, the choice of weapons system, the development of institutions for managing satellite communications, and Intellectual Property Rights in the transfer of technology across national borders. Policies toward scientific inquiry include the support of science abroad and cooperation in large scientific undertakings.

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[15] Ibid, p.99.

In the light of lessening East-West tensions, critical policy choices have also has been arisen in the US over, whether to pursue technological innovations in new weapons systems as the most secure path to stability, or to negotiate further arms control and troop reduction agreements with the erstwhile Soviet Union. Additionally, questions on how to deal with national defense are controlling or preventing the export of sensitive technologies, particularly when the military threat of the Soviet Union and Eastern Europe seems to have diminished dramatically are also being debated.[16]

Beyond these, there are interconnected issues are which are discussed a little less, but still remain important concerns needing a clear policy. This includes managing the telecommunications revolution, controlling costs in high technology medicine, confronting the ethical and practical consequences of prolonging life and of longer life spans, regulating public health and safety, finding clean long-term sources of energy, and controlling the climate and dealing with global warming etc.

II. b. *Role of Congress and Executive in Science Policy Making in US*

Congress is a complex organization with complex political and policy tasks. Its members respond to a wide range of goals, incentives and constraints as they attempt to promote both the public and their self interest. Congress has several tools at its disposal to influence science and technology. It is a dominant force in four of the five major stages of policy process- perception, definition, formulation, adoption, evaluation and oversees the implementation of policies by bureaucrats. It is central arena for public policy making and the continuing

[16] Alexander L. George and Richard Smoke, *American Foreign Policy : Theory and Practice*, (Columbia University Press, 1987) Pp.47-53

focus for national politics because it undergoes elections every two years, has mostly open procedures and offers the media, interest groups and the voter's access to decision makers. The legislature is where policy and politics converge most dramatically. [17]

Congress has always been active in science and technology policy, and it has asserted a lead over the president on some of the issues. It uses, the tool of passage of law to shape the science and technology policy. However, before policies can be implemented, vogue mandates must be interpreted, to most of the policy making bureaucracies. For instance, much of the public health and safety regulation passed by congress since late 1960s has found its way into judicial system where courts have had to determine congressional inferred. Sometimes even a clear congressional mandate may be disputed or infrared. For example, the Occupational Safety and Health Act required regulators to reduce worker exposure to hazardous substances to the lowest extent feasible, regardless of the cost of employers. However extensive judicial responses were consumed over ten years before the Supreme Court ruled in 1981 that Congress meant what the law said. So regardless of the specificity of its mandates, Congress has faced difficulties enforcing its will.

However in some cases the Congress has affected science and technology policy without going the full route to passage of a law. Normally, statutory policy change must pass many tests in the legislative process. Sometimes an exposed discussion is sufficient either to alter the implementation of a policy or to reduce proposals for new policies. Specific Bills are rarely used to proclaim broad directions for science and technology policies, and very narrow matters,

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[17] Richard Brake, "Congress in the Policy Process", in *Science Technology and Policy Process*, (New Delhi: Affiliated East-West Press Private Limited, 1988), p.24.

such as a case of misused federal funds, are not appropriate for full legislative action.

Congress occasionally undertakes a comprehensive examination of science and technology Policy. In 1980, the Allison Commission, a Joint Commission of House and Senate, investigated the Federal Science Organization. This commission has had several modern incarnations.[18] During, the late 1960's sub-committee on government research, chaired by Senator. Fred Harries spent three years discussing the long term implications of scientific research. In January 1985 the House Science and Technology Committee under chair Don Fuqua, established an eighteen month "Task Force on Science Policy" to provide a comprehensive analysis of the relationships of science to government, education, industry, manpower and foreign relations.

The role of Congressional Committees is to investigate particular issues through staff studies and public hearings. The dominant committees in Science and Technology policy are the House Science and Technology Committee and the Senate Commerce, Science and Transportation Committee, each of which are divided into numerous specialized subcommittees (see table-1). Nearly all Congressional Committees can influence various aspects of science and technology policy as they authorize new programmes and expenditures.

If congress fails to gather information, it generates controversy that may affect policy. After a fire killed Columbia and its astronauts, the National Aeronautics and Space Administration (NASA) was strongly criticized for refusing to release "intimate and confidential" information about the accident to

[18] Harvey A. Averch, in *A Strategic Analysis of Science and Technology Policy*, (Baltimore: Johns Hopkins University Press, 1985), p.17.

Congressional Committee. NASA's administrator promised to keep committee members better informed.

One of the most effective tools of congress is its power of purse. With growth in federal R&D expenditure, Congress has acquired more budgetary opportunities to shape science and technology policy. Because the process consists of two stages (programme authorizations and appropriation), performed in both the Senate and House by committees whose jurisdictions may overlap, the science and technology budget is subjected numerous influences before the President has a chance to sign it into law. Since President begins the budget process and congress has a limited time and resources to review it, only controversial items are subjected to significances changes by Congress.[19]

A question arises that whether the members of the Congress have that required knowledge of science and technology for the policy making process. Although, they are unlikely to be scientists or engineers, it is still possible for them to hire well trained legislative staff to help them to formulate and analyze policies with scientific or technological contents. A small, but increasing number of staffs are trained in science and technology, by applying their training they not only save members large amounts of time but also make possible for Congress to compete with expertise found in agencies and executive branch. To assist legislature with scientific and technological issues, several scientific associations, such as American Association for Advancement of Science (AAAS), American Physical Society, the American Chemical Society, and Institute of Electrical and Electronics Engineers, appoint professional scientists and engineers as Congressional science fellows.

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[19] Joan Lisa Bromberg, *Fusion: Science, Politics and the Invention of a new Energy Source,* (Cambridge: MIT Press).p.27.

Science Committees and Sub-committees (Table-1):

Committees	
Senate Committee on Commerce, Science and Transportation	
Sub-committees	Aviation
	Business, trade and tourism
	Communication
	Merchant Marine
	Science, Technology and Space
	Surface transportation
	National Ocean Policy Studies
House Committee on Science and Technology	
Sub-committees	Energy, development and applications
	Energy, research and production
	Investigation and oversight
	Natural resources, agriculture and environment
	Science, research and technology
	Space science and applications
	Transportation, aviation and materials

[Source: Congressional Quarterly Inc., 99th Congress Committees, 1985-86(Washington D.C; Congressional Quarterly Inc., 1985) pp.32-33, 70-72]

Presidents have always been important figures in shaping science and technology policy, but the increasing of federal research establishments after World War-II has caused that influence to grow further. Their control of information from domestic and foreign policy bureaucracies, coupled with their political prominence, gave them a special ability to shape the political agenda. The Congress often waits for a sign of presidential agreement before acting on a legislative proposal. Similarly, a mere hint of White House support can be parlayed into legislative influences.

The President has some distinct advantage over Congress in the use and manipulation of science and technology policy and in establishing priorities and possibilities for research and development. Constitution has allowed President to develop an active role in science and technology policy. Although Congress, the Bureaucracy, and the Court may impede him through statutory and other devices.[20]

As commander chief of the American armed forces, the President can take a wide range of actions in the name of protecting the national security with Congress acting as only a partial constraint. Although President must have the cooperation of Congress in authorizing and funding the development of new weapons systems, they usually get most of what they request. In addition, much of the R&D budget is invisible to the public and even to most of the members of the Congress.

The President also has an important constitutional function in the legislative process, he may recommend legislation to congress, and he may choose whether to sign bills into law or veto them. The process of recommending policies usually entails far more than a brief mention during a state of the Union speech. A science or technology policy may be formally introduced in Congress by a member of House or Senate as an Executive Request (such as Gerald Ford's proposal that led to the National Science and Technology Policy, Organization and Priorities Act of 1973). However it is more common for the members of the President's Administration to press Congress for new or changed policies

[20] James Ferguson, "National Security Controls on Technological Knowledge: A Constitutional Perspective", *Sciences, Technology and Human Values*, Vol. 10, spring, Pp.87-98.

through informal channels or testimony at hearings. In pursuit of these legislative goals the White House can usually recruit associates from the public, industry, interest groups and sometimes even foreign nations. European technology companies, for example, not wanting to left out of the R&D wind fall flowing from Reagan's strategic difference initiative, urged their governments to endorse the American defensive weapon proposal, which had the effect of putting pressure on Congress to fund Reagan's requests.

Many times the President's veto power has been used to shape both general and specific science and technology policies. Harry Trumann vetoed the first Congressional attempt to create the National Science Foundation in 1947 because its director, though ostensibly executive officer, were too insulated from the President.[21]Ronald Regan vetoed legislation that legislation that would have established new institutes within National Institute of Health (NIH), arguing that Congress has tried to create "unnecessary, expensive, new organizational entities" and that the Bill would have usurped the President's authority to set policy for NIH.[22]

The President has two additional functions that allow them to affect science and technology policy. First, they have the power to appoint the top administrators of most federal offices, or, if required to nominate them for Senate conformation, which is usually forthcoming. By this device President not only can select men and women of compatible ideology to manage government programmes but also can send a message to Congress and Civil Servants about policy changes to expect .For example, when Jimmy Carter (Who had taken strong position against Nuclear Energy) had the opportunity to name a Director

[21] James Penick "Harry S. Trumann", in *The Politics of American Science: 1939 to Present*, (Cambridge: MIT Press, 1977) p.35.
[22] Norman Collin, "President Vetoes NIH Bill", *Science*, vol. 226, 16 November, 1994, New Delhi, Pp.811-812.

of the Energy Department's energy research programme, his choice was a man with experience in nuclear fusion.[23]

II. c. *Science and Technology as an Instrument of Foreign Policy*

The main objectives of the US foreign policy during the Cold War were to maintain the superiority over Soviet Union particularly in cutting edge technological developments.[24] The arms race between former USSR and USA during the Cold War could be regarded as "technological race". Indeed, the USA took this race very seriously ever since the Soviet Union succeeded in demonstrating its nuclear weapon capability. The losing the nuclear monopoly to Soviet Union in the fall of 1949 came as a rude shock to the United States.[25] What caused much concern to the US was the considerable evidence that the Soviet were successful in obtaining its nuclear technology know-how through the covert means.

As some studies have shown, the US, apart from its East-West problematic foreign policy with the erstwhile USSR, was aware of its North-South foreign policy challenges. The US was no doubt inclined to heed to the developmental needs of the south. But the fact that most of the nations of the south increasingly adopted the socialist model of planned and controlled economy and showed signs of tilt towards Soviet Union, caused a great deal of anxiety in the US. In effect, the US assumed that the countries of the South (those from Asia, Africa and Latin America) as surrogates of the then Soviet Union. As apprehension grew, so did its policies regarding transfer of technology. The United States' contention that the countries of the South could be used by the then Soviet Union

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[23] T.A. Heppenheimer , *The Man Made Sun: The Quest For Fusion Power* (New York: Little Brown,1984),p.43

[24] Robert D. Schulzinger, *American Diplomacy in Twentieth Century* (: Oxford University Press, 1984.)p.108

[25] Allan B. Bromley, "Science and Technology: From Eisenhower to Bush", *Presidential Quarterly* (Washington D.C) Vol: 21.Spring, 1991, p.243.

as effective conduits to gain access to its technology, further resulted in tightening of controls. But the US had to reconcile between the policy of containment and the policy of caution towards south. This predicament had considerable effect on its foreign policy. After the disintegration of the Soviet Union, the international balance of power underwent a sea change. Although the arms race and technology transfer dilemma vanished, new threats in one form of terrorism, environmental pollution and serious health hazards like AIDS has demanded regulation of sophisticated technologies. Under these developments, the challenges in front of the policymakers of US was to take sufficient pre-caution in order to make sure that the advanced technological know-how must not be misused. This agenda has been reflected in the formulation of US foreign policy. The terrorist attack on World Trade Centre on September 11, 2001 has also reshaped US foreign policy in significant ways. It is clear that in each circumstance the US foreign policy demonstrated a fundamental feature of keeping it always ahead of its adversaries in technology. This was considered as vital aspect of the American national interest.

The US demonstrated the problems, challenges and predicaments of its technological relations through various mechanisms. These mechanisms were placed at two levels, one at domestic and other at international level. At the scientific and technological front the President U.S. had assumed greater pre-eminence vis-à-vis foreign policy, as by this time science and technology became ever more important in the affairs of the Federal Government.[26]

[26] Timothy E Wirth, and Peter Cohen, "Science Technology and Foreign Policy" in *Science*, (News Series), (August 29, 1999) Vol: 277, No: 5330, Pp.1185-1187.

II. d. *Evolution of Science Policy in the US*:

The institutionalization of science and technology with a long term perspective started with President Eisenhower.[27] It was under his administration that the position of Scientific Advisor to the President was established as a part of White House. In fact these moves were promoted by the lunching of the Sputnik, by the Soviet Union on October 4, 1957. The Soviet success invited immediate hysteria response from US. Edward Teller's statement that "this country had lost a battle more important than Pearl Harbor", evidently summed of the pessimistic mood widely prevalent in the U.S. at that time. News papers editorialized about a national emergency. Many people were worried whether the Soviet Union had leap ahead of the US in science and technology. In response to the prevailing circumstances the President summoned the Science Advisory Committee of the Office of the Defense Mobilizations (ODM). Within eleven days after the lunch of the Sputnik. The purpose was to ascertain the US response to the 'crises'. The chairman of the committee Prof. I. I. Ravi of the Columbia University was certain that the President needed a man in the White House who could clarify the scientific and technological dimension of major foreign policy decision. After that James Killian the President of MIT suggested a few other resources. According to him the President should have a Science Advisory Committee that supported directly to him, rather the usual practices of going through the ODM nor became the President's Science Advisory Committee (PSAC).

Subsequently, the PSAC took some major decision which had far reaching foreign implications. They included the establishment of the NASA and

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[27]Victor Basiuk, *Technology, World Politics and American Policy*, (New York : Columbia University Press, 1987) Pp.78, 79.

formation of organizations to manage scientific information. It also dealt with issues dealt with the nuclear testing and nuclear disarmament. It was clear from this action that the US considered, the strengthening of the domestic institutions to be of paramount importance to deal with the ever increasing Soviet challenge.

One significant aspect had been that it brought perhaps for first time in the US history, that the President came into direct contact with science and technology specialties in order to assist him in foreign policy decisions. Unfortunately, the role of science advice lost its important during the Johnson and Nixon Presidencies. President Johnson did not give much attention to the scientists, perhaps due to his preoccupation with the developments in Vietnam. But this not to suggest that the scientist community too had become languid. In the contrary this was the period when the US succeeded in numerous scientific and technological endeavors. Most notable of them was the lunching of communication satellite and sending first ever manned mission to the moon.

In the early 1970s the relation between the President and the Science Advisor widened. Nixon deliberately neglected the scientists and scientific advising. In fact, the PSAC was abolished and the position of science advisor was wiped out. These actions were precipitate as a result of series of happenings, which are embraced the President. One of such instances, which invited the ire of the President, was regarding the testimony given by the members of the PSAC in the Congress. These members had testified against the Nixon administration's position relating to the Anti-ballistic plans and the Supersonic transport system.

After the President Nixon's resignation when Gerald Ford took over as new President, he promptly reversed many decisions of his predecessors. The

White House Science Advisory apparatus was established through PL94-282, which subsequently led to the formation of Office of Science and Technology Policy (OSTP).[28] In the new arrangement, the Congress was given direct access to the country's science and technology advisors.

In fact the Director of OSTP was to be appointed by the President and subject to confirmation by the Senate. With these actions, a long standing gulf between the legislature and the science advisory mechanism was bridged.[29] Consequently by the mid of late 1970s the President, the White House and the Congress assumed their legitimate roles to deal with the matters pertaining to science and technology in foreign policy.

Although PL94-282 had made provision for establishing the new PSAC, neither President Ford nor Carter took any major initiative in that direction. But when Ronald Regan took charge as the President in 1981, he went half way in establishing the White House Science Council (WHSC). Though functionally akin to the old PSAC, the council had minor structural differences. While the PSAC had been reporting to the President, the WHSC was designated to report to the Science Advisor. Since its formation the WHSC, it has been dealing with areas much diverse in scope and dimension. These were missions responsible for health of federal laboratories, colleges and universities, the control of the US air space and matters pertaining to industrial competitiveness. However, the issues of special interest since 1980 had been research in AIDS, anti terrorist activities, global environment issues, space exploration, and nanotechnology etc. All these

[28] Office of The Science and Technology Policy (1982) *Annual Science and Technology Report to the US. Congress*, , Washington DC, USGPO,p.11.
[29] Allan B. Bromley, n.25, p.244.

instances prove the importance attributed to science and technology in wake of serious problems confronting the US. It also recognizes the role of science and technology in contributing to the attainment of basic national and international goals of the US.

The regulatory accepts of technology transfer policy of the US had been conditioned by two broad approaches. They are- the domestic administrative approach and the international or the multilateral control approach. There is no hesitation that these approaches form the bed rock of US foreign policy pronouncements and actions.

III. US TECHNOLOGY TRANSFER MECHANISMS

III. a. The Domestic Administrative Approach: This approach deals with formulation of the guidelines and delegations of power to various federal agencies on science and technological issues. It gained prominence ever since the Congress demonstrated its interest in the technology transfer process from the mid 1972. As fallout of these, the domestic institutions got strengthened and they began to receive greater attentions.

Some of the important agencies and their functions are noted below:

III. a. i. *Office of the Science and Technology Policy (OSTP):* The office has been assigned the key task of implementing technology transfer policies by integrating administration actions. It also has a role in initiating new policies and programmes. These policies and programmes are assigned to the Congress when it was deliberated upon and formalized for action.

III. a. ii. ***Department Of Defense:*** This department has been assigned the specific task of making technical judgments about the technologies meant for military. Apart from that it is responsible for preparing the Military Critical Technology List (MCTL) for the use by enforcement and licensing authorities. In 1977 the secretary of defence Harold Brown while presenting the interim DOD policy statement on export controls of the US technology, stated that "the primary objective....is to protect the US lead time relative to its principal adversaries in the application of technology to the military capabilities" .[30]

III. a. iii. ***National Security Council (NSC):*** The NSC too has been conferred with special power vis-à-vis technology transfer policies. It has the task of institutionalizing the process of technology transfer. There is an evaluation and feed back mechanism that allows the decision makers to learn, to correct and to expedite in decision that have commonality in time and content. With these arrangements in hand the national security concerns has been weighed in relation to the foreign policy priorities, and technology policy thrust.

III. a. iv. ***Department of Commerce:*** This department is perhaps the most important of all federal agencies dealing with the technology policy aspects. Applications for export license were routinely screened and processed. Although accused of being slow in action, the DOC is considered very effective from economic and security points of view. One important feature of contribution of DOC had been its continued updating of the Commodities Control List (CCL). This List specifies those commodities which could be exported by various US companies.

III. a. v. ***Department of States:*** This principal foreign policy agency has been assigned the task of prioritizing technology policy decisions in the event of

[30] Philip Roberts , *Technology Transfer – A Policy Model* (Washington D.C: National Defense University Press, 1988.),p.66

foreign policy exigencies. Here foreign policy decisions are give precedence over technological judgments. As a result the administration might override or abide by other agency's decisions on technology transfer matters if it was considered to be in national interest.

III. a. vi. ***Central Intelligence Agency (CIA):*** Since its creation after Second World War, this agency had been playing a very active and significant role in US foreign policy. Apart from providing vital inputs, it accesses the capability and potential of the adversaries' world wide. In particular the technology transfer committee and the science and technology division has been operating together in this regard. They were also created for developing new and sophisticated techniques for intelligence gathering and for monitoring the technology. Infact the information provided by the CIA serves as a primary source for other agencies that deal with foreign policy, technology transfer policy and national security policy of the US.

III. b. The Multilateral Approach:

This particular approach is very significant due to its nature and scope. First it is followed by almost all the developed countries led by the US. Secondly, according to this approach a common agenda has been laid down in order to regulate and control international technology flows. The prominent multilateral mechanism that formed a part of this approach is as follows.[31]

[31] SIPRI (Stockholm International Peace Research Institute) Year Book-1991,(London: Oxford University Press, 1991), p.567.

III. b. i. *The Coordinating Committee on Multilateral Control of Exports (COCOM):*

This is one of the most successful mechanisms ever formed to control the export of technologies. It was established in 1949, comprising all NATO countries excluding Iceland, Australia and Japan. Located in the annex of the US Embassy in Paris, these 17 members group is believed to control over ten lakh advance technologies and industrial items. Besides maintaining the International Industrial List (IIL), COCOM also controls the International Munitions List (IML) and the International Atomic List (IAEL). While the IML deals with military relevant materials, the IAEL handles nuclear technology related issues.

In strategic terms the export control policy had been moderately successful. The availability of sensitive technologies to erstwhile Soviet and Eastern bloc countries had been made almost impossible. But this tightening of controls posed a serious constraint for the US business. The other members of the COCOM too faced similar problems, but they were comprised with in the interest of broader national security concerns. According to scholars, better safe than sorry philosophy had been the driving force behind such tough export control policies.

III. b. ii. *The Missile Technology Control Regime (MTCR):*

In 1985 &1986, the US worked with its six economic partners of the G-7, to establish the MTCR. This was to be done in the line with NPT. The MTCR was neither a treaty nor an exclusive agreement, but only a set of export control principle and guidelines.

The purpose of the MTCR had been to serve as an adjoin to the NPT. Their controls were to apply to any unmanned delivery system, including Ballistic and Cruise Missile system that can carry 500 kg payload to 300 km distances. The main apprehension was that such delivery system could be used to lunch nuclear attack on US and its allies, such an exaggerated apprehension had given adverse implications for peaceful space programmes in the developing countries such as India.

IV. SCIENCE AND TECHNOLOGY IN INDIA'S FOREIGN POLICY:

Since India's independence in 1947, science and technology have been enjoying the patronage of the government.[32] The role of science and technology were recognized as important factor that were capable of offering solution to India's problems both domestic and international. In fact science and technology have regarded as vehicle for development which contributes in increasing the national power of a nations, this also in turn influences the foreign policy and international relation.[33]

In case of India the role of science and technology in its foreign policy could be viewed from two perspectives. The first pertains to technological acquisition by India from other countries and second pertains to transfer of the same to the other countries. Both the perspective has been conditioned by the foreign policy of India and vice-versa. In order to have strong foundation of foreign policy, India adopted a strategy for setting up a broad based infrastructure for science and technology.[34] The industrial policy resolution of 1948 encouraged the participation of foreign capital and enterprise for India's rapid industrialization and this policy also opened the door for foreign technologies in to India.

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[32] Edwin Martin, *The US and Developing Countries* (West View Press, 1977) p.88.
[33] Ibid, p.2
[34] Baldev Raj Nayar, "Decision Making In Technology" in *India's Quest For Technological Independence*, vol. 2 (New Delhi: Lancer Publication, 1991), p.241.

The scientific policy resolution was adopted in 1958 and along with this policy thrust, a rapid expansion of R & D laboratories occurred through out the India.[35] According to another aspect of this policy there has been a consistent attempt to bring close link between the science, technology and socio economic development of the country.

For initial phase of development, India depended heavily on the import of technology to build up its industrial base. Thus in 50s, 60s, public sector industries were being set up with import of foreign technology (Martin, 1977). [36] This was the time when India began to follow Five-Year Economic Planning. The objective of the planning was to give thrust to sectoral development. As a result, the 1st five year plan (1951-56) laid emphasis on agricultural sector but during the 2nd five year plan (56-61); however the stress was given to industrial development.

Thus India's Post-Independence economic policy had been aimed at developing domestic industrial base in order to achieve rapid growth and economic Independence to go along with political independence. India's attitude towards foreign capital and technical assistance was articulated by Prime Minister Jawaharlal Nehru in parliament on April 6, 1949. He pointed out that foreign investment was essential not only to supplement Indian capital but also to secure scientific, technical and industrial knowledge with Capital equipments.[37]

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[35] Sandhya Sharma, "India and US: Technology Transfer and Foreign Policy", *Mainstream* ,(New Delhi, 3rd October 1992)Vol: 30, No.5, p.15.

[36] Martin, n.32 , p.21

[37] Jawaharlal Nehru, *Selected Speeches* (1946-64), Volume-I to V, (New Delhi : Publication Division , Ministry of Information and Broadcasting.) p. 33

As a result, during this time the MNCs, particularly the companies of the US were allowed to operate in India. In 1960s, the MNCs gained dominant market shares in key industries such as chemical, electric machinery and computers.

But much of the MNCs investment involved collaboration with large Indian business houses. The MNCs were diversifying their activity and were growing in economic power and influence. This began to cause a grave concern to the Indian government. In order to check such tendencies it restored to certain legislative measures. Accordingly, the Monopoly and Restrictive Trade Practice Act (MRTP) was passed in 1969. This was followed by the enactment of Foreign Exchange Regulation Act (FERA) in 1973 .These measure were aimed at safeguarding the economic interest of India. Thereafter, vexed with such tendencies by the MNCs, India began to implement a strategy of Import Substitution Industrialization (1st) since 1960s. This was very challenging proposition considering the fact that India was in initial stage of economic recovery and development.

Thus the technological aspects always have been the guiding principle of India's foreign policy. The decision to seek and acquire a particular technology from a country depended on the effectiveness of India's foreign policy. While doing so, care was being taken to ensure that either the technology or those who transfer it must not create an adverse impact on India. India was of the opinion that technology holds the key for its successful evolution as an economic independent nation.[38]

India always has the strong preference for the American technology. This was due to the fact that, by the end of the World War-II, the US emerged as a world leader in science and technology. India's effort to gain access to US technology was evident from Nehru's visit to US in October 1949. He made a convincing appeal in the United States by stating that:

> *"India has numerous well thought out plans for industrial and agricultural development. We do not wish to take risk about these jobs. The USA is among the best countries that have at its disposal the things needed to carry out Indian plans to success. India wants machinery, tools and various types of technical appliances. As regarded as the know – how we want the best types not only in theoretical framing but also in experienced. He further said that the US is one of the very few countries which as such people of experience on training at its disposed. These are among our main demands."*[39]

It is acknowledged that India had spearheaded the demand for creation of a New International Economic Order (NIEO) in early 1970s. One important aspect of NIEO was the transfer of technology from developed to developing nations. According to India, the former colonizers and exploiters who formed the developed North owe restitution the south for past transgression. Another View was that, the economic models of the North offered solutions to the problems of economic underdevelopment of the South.

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[38] Baldev Raj Nayar, n. 34, p.243.
[39] Jawaharlal Nehru, n.37, p.234.

India always spoke on behalf of the developing countries. It emphasized that the developed countries were force fully imposed their technological superiority over the developing ones, while the latter ones are not always in the position to absorb them. So a cautious approach to this aspect should follow in order not to incur the wrath of the developing countries. India also convinced that the advanced technology could not provide ready made solutions to the myriad social problems, unique to the developing countries. Therefore the stress was on appropriate import of technology. But there were problems pertaining to the choice of technology and its export also to the ability to purchase and apply the same.

There was also a predicament for India. It harshly criticized the US policies towards Korea, Vietnam and in the African and Latin American countries during the 1950s and 1960s. As a result, it was but natural that India was favored less by the US for any outright assistant. India too was resistant to seek the US assistant after being critical of its policies.

India, however viewed the erstwhile Soviet Union and its policies as essential favoring the developing countries. No doubt, that India was aware of the limitations of the soviet technology, but India made the choice for the Soviet assistance. There were political and economic reasons attributed for these choice. First the Soviet Union was willing to support India's case in the United Nation's Security Council over Kashmir issue and over the policy of decolonization. Second, as the India's adversary namely Pakistan began to enjoy the patronize of the US, it was a tactical move on the part of India to get support and assistant.

As regards technology the Soviet were prepared to transfer it to India on flexible economic terms, with almost no conditions attached. There fore India continued to relay on Soviet Union for defense and industrial technology. Despite this fact, the US made significant contribution to India's technological needs. India's effort to seek technological assistance was thus a test to its foreign policy. But, the result had been impressive. It was able to make all of US –Soviet antagonism for its benefit. India was also in a position to get assistance from both US and Soviet Union by making efficient diplomatic moves. It was also able to mobilize the support of developing countries by sphere heading the collectivity. In the process it gained much prominence and attention leading to the benefit of its economy.

In other words, this could be seen operating at three levels. At the first level India was able to get the US assistance by projecting its democratic credentials and using the Soviet Union as trump card. At the second level, India sought the Soviet assistance when the US assistance was denied or when it found it be conditional and costly. Finally at the third level India used its clout among the developing countries to make collective demands for economic and technological assistance from developed countries.

In the Cold War Period India was in the dilemma about the choice of technology export and the technology itself. Its foreign policy was based on principle of non-alignment policy. The objective was to keep away from the superpowers, namely the US and the Soviet Union. Therefore it was felt that preferring the technology of the US over the Soviet Union and vice versa could undermine the neutral ideology and also convey a wrong signal. With the end of Cold War situations under gone sea change and dilemma of choice for technology procurement vanished. The policies of Containment and Non-alignment gradually declined in importance. The relations of India with America, the lone superpower suffered waxing and waning depending on several developments in the international arena. The United States imposed sanctions against India following India's nuclear tests in 1998. However the sanctions and other constraints vanished after the United States recognized India as one of its strategic partners in the War on Terror which was declared on the wake of 9/11. This changed India's scientific and technological relations with the United States .These changes in the Science and Technology cooperation form the substance of the next chapter.

Chapter -2

INDO-US SCIENCE AND TECHNOLOGY COOPERATION: NOW AND THEN

I. A HISTORICAL BACKGROUND OF INDO-US SCIENTIFIC AND TECHNOLOGICAL COOPERATION:

While developing an autonomous capability in science and technology was India's long term objective, the short term objective was different. The absence of capital goods industries at the time of independence and lack of research and development capabilities within the country, technical assistance from the industrialized nations was the only pragmatic course for India.

India's leadership had indicated its preference for such short term technology import policy even before the Independence. Jawaharlal Nehru, the Chairman of the Indian National Congress (1938) had raised his voice that government initiatives "would facilitate the supply of technical export and skilled labour in case our own resources in that behalf are not found adequate for the rapidly developing Engineering Industries of the country".[1]

I.a. Crave for the US technology in post-Independence period:

After Independence, the Industrial Policy Resolution of 1948, promised to regulate the capital in the national interest and also to insist upon the training of suitable Indian personnel for the purpose of replacing foreign experts. After that, more liberal attitude towards foreign capital and technical assistance followed within a year. In the Prime Minister's statement to parliament on 6th April 1949 the earlier threat of legislation to cover foreign investment was dismissed. The foreign investment now thought to be merely useful, and necessary to supplement Indian capital, for acquiring the scientific, technical and industrial knowledge.[2]

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[1] Bidyut Chakravarty "Jawaharlal Nehru and Planning, 1938-41: India at Crossroads" in *Modern Asian Studied*, (New Delhi, May 1992), Vol: 26, No. 2, pp.275.
[2] United States Department of Commerce, *Invest in India*, (Washington, DC: USGPO, 1953), p.107.

The government's willingness to relax its industrial policy for obtaining certain foreign technologies was soon visible in deals with the foreign oil companies in 1951. In the 'Refinery Agreement' signed by the Government of India with the American Standard Vacuum, British Shells in 1951, and later with American Caltex in 1953, the companies were exempted from nearly all the regulatory legislations and rules promulgated since independence. [3]

During this period when foreign technology, particularly in the strategic areas, was being sought by India, the preference for US technology was unmistakable. This was understandable as the United States was considered as the world's leader in modern science and technology at that time.

India's interest in the US technology was evident from the considerable efforts that Indian diplomats made in this direction before and after Nehru's visit to the US in October 1949. Prior to his visit, the Indian ambassador to the United States, Mrs. Vijaylakshmi Pandit went on a tour of the country and met several important personalities, particularly in the field of business. She was forthright in emphasizing the role of America could play in the India's technological development. For instance, in a broadcast from New York in June 1949, she observed that "it is particularly in the field of industrial expansion that we need the help of America. I believe in the fact that India may be the last great area of trade expansion available for American industries which must keep producing America's economic health".[4] This appears an incredible statement but, only in conjunction with the other attempts that were being made at that time to attract the US technology to India. It showed the urgency attached to technological development by the Indian leadership. Almost at the same time when Indian ambassador was trying to create a favorable climate, India was busy in

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[3] Michael kidron, *Foreign Investment in India,* (London, oxford University Press, .1965) p.90.
[4] Jawaharlal Nehru, *Speeches* (New Delhi, Publication Division, ministries of information and broadcasting, Government of India., 1958) Vol: III, p.103.

identifying the areas in which the American assistance could be most productive. Dr J.C Gosh, Director General, Ministry of Industries and Supply, had written to B.R Sen, Minister of Indian Embassy in Washington, that American assistance would be particular welcome for steel, pig iron, industrial machinery, and fertilizers.

The visit of Indian Prime Minister to the United States indicated the rising expectations of India in terms of help in Science and Technology. In United States, Nehru left no doubt about the areas in which he expected liberal assistance from the United States. In a most comprehensive statement on India's requirement that he made during his visit he pointed out that:

> "India had numerous thoughtout plans for her industrial and agricultural development. We don't wish to take risk about this job. The US is among the best countries that have at their disposal the things needed to carry out Indian plan to success. India wanted machinery, tools and various types of technical appliances.......As regard know-how we want the best type. The US is one of the very few countries which have such people of experience and training at its disposal. These are among our main demands". [5]

India's desire for the US technology was even more clearly reflected in the specific requests for the US arms, which was made by the Indian representatives to their American counterparts during this period. In Washington, Col. B.M Kaul, India's military attaché, contacted Colonel Garling of Department of Defense in January 1948 and informed him that he (Col. Kaul) was authorized to

[5] P.M Kamat "Indo-U.S. Relations: Dynamics of Change" in *The Journal of Asian Studies*,(New Delhi, May! 989) Vol: 48, No.2, pp.426-427.

negotiate immediately with the US Army to obtain, 1000 jeeps for the Indian Army, 12 B-25 bombers by May of 1948, 31 additional B-25 to be obtained later, and to effect preliminary arrangement, towards the placing of thirty aero-engineers in US Air Force technical schools beginning in the fall of 1948.

India's quest for American technology in building up its air force was also evident from the efforts made in 1951 on the "Vampire Projects." This was a prestigious project which depended largely on the US technical assistance. Its importance to India was understood when the economic attaché in Indian embassy in Washington took of the matter with the Department of State. [6]

A major factor conditioning India's Western and particularly pro-American orientation at that time was its economic and technological dependence upon the Western democracies. Despite Soviet efforts since the war to strengthen its commercial relations with India, the overwhelming bulk of the trade was with the countries of the West. These countries were at that time the chief suppliers of Indian needs and principal markets of Indian exports, which were overwhelmingly primary products. Moreover it was only to the West and US that India looked for the capital goods and technology that was so clearly needed for its industrialization.

One of the major foreign policy decisions that revealed India's pro-West inclination was its effort to become a member of the Common Wealth in 1949. While India's economic ties with the Western world were of major importance in making this decision, non- economic factors too were visible. Among them was India's need for defensive alliance. The government of India was fully conscious of India's military, and particularly its naval weakness and its consequent

[6] Jawarharlal Nehru, n.4, p.162.

inability to defend itself against the foreign aggression or to keep open the see lanes upon which its commercial life depends.

India's pro-Western leaning at that time was based on considerations of political as well as economic expediency rather than any feeling of natural affinity or antipathy towards either of the power blocs. However, there was a limit beyond which India was not prepared to side any power. This policy of limited political alignment with the Western bloc, and particularly with the United States, which had emerged as new leader of the bloc after the WW-II, fitted well with the technological strategy pursued by India at that time. What India required at that time form United States was technological assistance of a scale and character that could transform India in to major power in its own right. The objectives made it necessary that India aligned with US on a limited scale. The need and the limit of the alignment was neatly summed up by Nehru in one of his letters to Krishna Menon –"align with United States some what and build up our economic and military strength"[7]

As some experts have stated the over ridding goal that determined India's technological strategy as well as the policy of limited alignment with the US, was to make India a modern technological power that "counts in world affairs". Nehru visualized great power status for India, along the side of the United States, Soviet Russia, and China. Accordingly, it was this goal more than anything else that made it almost certain that question of any technological assistance that India desired from the United States would be interlinked with foreign policies of the two countries. The US was pursuing at that time a

[7] Jawaharlal Nehru, " The Importance of National Idea" in The *Discovery of India*" (New Delhi, Oxford University Press), p.501..

conscious policy of using its technological asset as an instrument of its foreign policy.[8]

I.b. Indo-United States Technology Cooperation in 40s and 50s

The US involvement in India's technological development can be traced further back than India's interest in the US technology. It began in 1942 when an American technical mission visited India to advice the British government on the possibilities of American assistance in developing the industrial resources of the country for the war efforts. The United States agreed to send this mission as it would increase India's war effort that depended largely on the US technological help. At the same time, however, the mission was not averse to exploring avenues for closer ties between the US and India. The mission's purpose has been to attempt to inaugurate a period of closer collaboration between India and the United States. It facilitated many conferences in New Delhi and Jamshedpur with Indian government officials and industrialists.

The *'Point Four Programme'* and its Implications:

After India's independence, the US interest in providing technical assistance to India became enmeshed with its policy of combating communism. By 1949, when President Truman announced his *'point four programme'* of technical assistance to the developing countries to meet the perceived communist challenge in Asia, this programme also carried some technical rationale. Truman made a statement regarding this programme:

[8] M.S Venkataramani and B.K Srivastav, *Roosevelt, Gandhi, Churchill*(New Delhi, Radiant, 1983), p.25

> "Take full advantage of the almost universal yearning for better conditions of life throughout the world .....And harness their enthusiasm for social and economical progress to democratic campaign to repulse communism".[9]

The vital importance of this programme to America was stressed by the then Secretary of Agriculture Brennan in September 1949.In his testimony before House Foreign Affairs Committee, Bernnan explained that "the United States is geared to a high level of production, both in firm and industry, and we need sound markets overseas in order to stay in gear". Technical assistance to the developing countries was expected to make those countries familiar with United States products, and open up opportunities for increased US agricultural exports to those countries.

India signed the programme because technical assistance was seen as necessary to lay the ground work for productive investments abroad. Technical surveys of resources and the possibilities of economic development were considered essential by capital investment flow from the US. Further, in many areas technical assistance in improving sanitation, communication, or education was required to create conditions in which capital investment could be fruitful.[10]

Politically, technology was used as an instrument to combat and contain communism and economically it was used to promote the US private investment abroad and to secure the supply of strategic materials.

At the time when India had shown keen interest in obtaining the US technology both for military and economic purposes and when the US was following a

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[9] Chalmers M. Roberts (1949), "President Asks $ 5.8 billion Foreign Aid", in *Washington Post*, (on Line Edition) Accessed on December 15, 2006. URL: http://pqasb. pqarchiever.com/washingtonpost-historical/access/214282292.htm? dids =21428.

[10] John P. Ferris, *"Some* Lessons of United States-India Foreign Aid Programme" in *Public Administration Review*, (New York, 1955), Vol: 15, No.2, p.89-95.

conscious policy of using technology as an instrument of it's foreign policy, serious differences appeared in the US on the state of international affairs. Primary concern of the United States was the rise and expansion of communication. While apparently these issues were of little direct importance to the Indian interests. These issues related generally to the alleged communist expansionism in Asia.

These "serious foreign policy conflicts" almost made it certain that technological flow to India were to be severely restricted. For it was precisely at that time that the US government had enacted the Export Control Act of 1949. This act had ushered in the area of maximum use of the US technology controls. It declared that the US policy was to use export controls over products and technical data that extent necessary vigilance over exports from the stand point of their significance to national security. At the peak of the Cold War, the Department of Commerce had a 'positive' commodity control list of about 1000 items that were considered strategic and normally not exportable to unfriendly countries.[11]

The US government believed at this time that India's bid for leadership in Asia was bound to be restricted by the smaller nations and this would upset Asia's balance "Pakistan may be counted on to contest strenuously any Indian effort to obtain such leadership in Asia .....Ceylon and Nepal......fear that Indian ambitions threaten their national integrity.[12] As a result, the conscious policy of United States was to maintain parity in military strength between India and Pakistan and to keep Indian military potential in check. Consequently, the US disapproved projects like the 'Vampire' program which sought to establish India's air superiority. Perhaps the only technologies that the US was prepare to

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[11] Goldman Marshall, *Detente and Dollars*,(New York, W.W Norton, 1975) p.49

[12] Jermyn B. Cohen, "India's Foreign Economic Policies", in *World Politics*, (Washington, DC, July 1955), Vol: 07, No.04, p.595.

help India with, were in the fields of agriculture, public health, education, labor, power development and transportation.[13]

To sum up, although India did not have a formal science and technology policy during 1950s, its priorities in this were clear. In consonance with India's foreign policy objectives, these priorities were to build an autonomous capability in science and technology, particularly in areas like heavy and armament industry, oil and atomic energy, which would directly serve the ends of national power. While these were the long term priorities, in the short run foreign technological assistance was welcomed, especially from the US which was seen as the most technologically advanced nation.

The Mutual Defense Assistant Agreement that the US signed with Pakistan on 19th may 1954 was the culmination of a long and careful initiatives to use Pakistan for the promotion of the strategic objectives of the US.[14] By drawing Pakistan in to alignment with the US -led military bloc, the US brought Cold War to the South Asian region. The prospect of increased American civil and military aid was bound to affect India's policy towards the region. Even while the US -Pak alliance talks were still in progress.[15]

I.c.The challenge of the 1950s:

The US policy on aid to the developing countries underwent significant change in the late 1950's. This was due to the influence of a wide variety of impulses. Among these were the emergence of Soviet foreign aid programme on a big scale and the apparent high momentum of the Chinese economy during the first half of the 1950's. On top of these came the lunching of Soviet satellite Sputnik in 1957

[13] US Department of State, *Policy Statement – India*, (Washington D.C., National Archives, 1 Dec.1950) Ref. no. 611.91/10-1950,

[14] M.S Venkataramani, *American role in Pakistan* (New Delhi, Radiant, 1982), p.299.

[15] Ibid, p.300.

which gave a rude shock to US technological superiority .Soviet success in space was seen as a symbol of emerging challenge from the communist bloc in science and technology. Another aspect of communist challenge as perceived in then US was the economic performance of China, which was assisted technologically and economically by the Soviet Union on a very large scale. [16]

Senator John F. Kennedy, who actively supported large scale US aid for India, referred to the attractiveness of the Chinese model in his speech in the Senate in February 1959. In a statement he observed that:

> "To the nations in a hurry to emerge from the rut of underdevelopment, communist China offers a potential model.1958 was their round. As their trade and aid offensive mounted , as their own example proved more attractive, our trade and aid programme faltered and our economy stood still .....But 1959 could be our 'round' year."[17]

It was mainly in response to these developments that the US began to reconsider its foreign aid policy and took steps to meet the challenges posed by communists' initiatives in the third world. Among the first steps taken in this direction was the creation of the development loan fund in 1957 and International Development Association in1960. During the Kennedy administration, these efforts received further impetus and the new president was successful in receiving form Congress the authority to make long-term aid commitments. He was also able to strengthen the "Aid India Consortium Arrangements" in the World Bank with a strong American contribution. This

[16] Walter A. MC Dougall, "President fails as National Shrink: On Lesson of Sputnik", in Review *in American History*,(Connecticut ,Red grave Resources, December 1994), Vol:21,no.04, p.699.

[17] W.W.Rostow, *Eisenhower, Kennedy and Foreign Aid* (Austin, University of Texas press, 1985), p.27.

consortium had been lunched in 1960 in response to the 'exchange crisis' faced by India during the second Five-Year Plan. [18]

To the years of Kennedy administration (1961-63) experienced some of the major projects in technological collaboration between India and the US. Like Bokaro steel plant, Tarapur Atomic power project, and arms transfers following the Sino-Indian war. These highlighted the foreign policy considerations and technology transfers policy of the United States. The Bokaro steel plant project provided some evidence of increased technological assistance that became available to India as a result of changed external environment. The Tata steel mill at Jameshdpur had been built at the turn of the century with the assistance of American expertise, as the Indian officials thought of the US as the undisputed leader in world steel technology. Form the beginning of the project plan, America showed interest in supporting the plant. The details of the original conception and implementation of the Bokaro steel plant were set fourth in a note entitled "Bokaro steel project-problems of implementation" prepared by the Indian Planning Commission in 1961. [19] The Planning Commission based its initial conception of Bokaro on the possibility of the American aid. It was hoped that American aid would finance the purchases of equipments from the US suppliers and the services of few American steel techinicians, where as practically the entire requirements of structural and contractor services would be meet from indigenous sources.

The optimism and confidence that pervaded the Planning Commission's note indicated strong political support to the project in both the countries. Due to Chinese hostility and the goodwill generated by Eisenhower's visit to New Delhi in 1959, Nehru seemed friendly to the US and was willing to turn to that country

[18] James R. Roach, "Reflection on India's Second Five-Year Plan", in *Far Eastern Survey*, (London, 1956), Vol: 25, No.10, p.32.

[19] Padma Desai, *Bokaro steel plant* (Amsterdam, North-Poland publishing company , 1972) p.16

for the new steel plant at Bokaro. He was confident that the US would, under pressure, accept whatever proposals India might make for the US assistance for that project.[20]

On the US side, aid for Bokaro provide an opportunity to put into practice the US policy that was being formulated in response to Soviet aid initiatives in India. In this regard much effort and initiative was made by J.K Galbraith., the new US ambassador to India. In his first press conference in April 1961 he put the public sectors steel plant at Bokaro with in the range of American aid. At that time he did not even have specific instructions to that effect from his President. [21]

The US administration's support to the Bokaro project was primarily a political move and was given in response to the Soviet assistance to projects like the Bhilai Steel Plant .Apart from meeting the Indian demand for steel, Bokaro was thus seen as a propaganda play to steer Indian policies in a direction favorable to the US. While steel was one area in which the US showed willingness to assist India with both funds and technology, a different stance was visible in the field of nuclear energy. India's nuclear research programme began in 1944 with the establishment of Tata Institute of Fundamental Research at Bombay. [22]

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[20] James R. Roach, n.18, p.33.

[21] J. K Galbraith, "A Personal Account of Kennedy Years", in *Ambassador's Journal*,(England, Hamilton Publication , 1962), p.31.

[22] TIFR (1982), Tata Institute of Fundamental Research, "Genesis and History" Accessed on November 20, 2006, URL: http://www.tifr.res.in/scripts/context_r.php? schoolid=termin inodeid=1050 & deptid=& php.

I.d. Indian nuclear programme:

The long term strategy for nuclear power development in India had envisioned the reliance on local source of fuel.[23] However, even before the implementation of the strategy could be initiated there was one radical departure from its organic unity. In 1958, before launching of long term programme for nuclear development , the government took the decision to establish a nuclear power station as a means of acquiring the know –how in this complicated field . In October 1960, after two years of planning the Atomic Energy Commission called for bids on the construction of two MW electrical nuclear power reactors to be constructed at Tarapur near Bombay. The original requisition asked for bids only on reactors which would use natural uranium as fuel. However, later on at the urging of a US company the requirement was modified to permit the submission of bids on enriched uranium reactors also. Such reactors were then in commercial use only in the US. [24]

In June 1962, Glen Seaborg, Chairman of the US Atomic Energy Commission, visited India as representative of International Atomic Energy Agency (IAEA).[25] As a result of this visit, the US announced an $80 million loan to set up an enriched uranium power reactor at Tarapur on a turnkey basis through General Electric Company.

The Tarapur project provided a good opportunity to the US to further its foreign policy objective in the region. During 1962, the US was already aware of an impending nuclear test by China, and Tarapur represented an opportunity for

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[23] Onkar Marwah , " India's nuclear programme : Decisions Intent and Policy , 1950 – 1976" , in William H . Overholt (Ed), *Asia's nuclear Future* (Colorado, West View Press, 1977), p. 164.
[24] Ibid, p.165.
[25] James Everett Katz, "Scientists , Government and Nuclear Power ", in J.E Katz and O. Marwah(eds.), *Nuclear Power in Developing Countries* (Lexington ,Lexington Press, 1983) p.63

the United States to counter the perspective explosion of atomic device by China. Since India had agreed to the safeguards regarding fissionable materials, the US also managed to achieve its non-proliferation objectives in this case. In addition, Tarapur also symbolized support to India's strength vis-à-vis China, which the US was only too eager to bolster up to a point. This objective coincided with India's own desire to establish strategic ties with the US to protest further Chinese threat to its security.[26]

The Sino-Indian rift that provided the context for the US assistance in nuclear energy to India also determined the magnitude and type of military assistance that the US decided to give after the border war in October 1962. For the US, military assistance to India was not a simple issue of safeguarding India's security against Chinese aggression since the primary US objective in this region was to deter the communist expansion rather than to increase India's strength. So limited military assistance was all it was prepared by the United States to offer to India.[27]

The issue of transfer of military equipment from the US to India was not merely one of the requests made by Indian Prime Minister to the US government. Like the Bokaro and the Tarapur projects, arms transfer was too considerations by the US of Asian and even of the global strategy.

[26] J. K Galbraith, n.21, p.33.
[27] James Everett Katz, n.25, p.65.

I.e.United States cooperation in the field of agriculture:

The central problem of the US agriculture in the post World War-II period has been overproduction. While that provided relatively low, stable food prices to the American consumer, it also lowered the US firm income and; led to the creation of vast commodity surpluses. Soil fertility, large quantity of arable land, agricultural research and education, and improved inputs and machinery, all contributed to high levels of agricultural productivity, while demand for agricultural products remained static or declined.

By the mid of the 1950s, the American foreign agricultural policy, primarily carried through the vehicle of PL480 passed in 1954. It becomes a means of disposing the domestic agricultural surpluses abroad on bargain basement terms. The US policy on agricultural export was received favorably in India. In the second half of the 1950s, import of the food grain had become an established policy of the Indian govt. This was necessitated partly by the fact that in the second Fiver Year Plan beginning in 1956, the emphasis had shifted from agriculture to industry. Food imports were considered necessary not only to alleviate food shortages but also an integral part of the over all food policy of the country. [28]

The result of India's import based on food policy was due to the agricultural output lowered significantly during the second half of the 1950s. India signed its first agreement with the US under PL480 in 1956, and secured imports of $ 305.9 million worth of agricultural commodities. In 1959, at a time when it was costing the US $1.7 million a day to store surplus food grain, India approached the US for additional food grains. The rising price of food grains, the

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[28] Brady J. Deaton " Public Law 480: The Critical Choice" in *American Journal of Agriculture Economics*, (Washington, DC, 1980), Vol:62, No. 3, p. 988.

fast depleting stocks and the tight foreign exchange situation prompted India to seek large scale food assistance.

Technological packages of agricultural machinery, fertilizer, and pesticides which were introduced in India during the 1960s were finely tuned to the needs of the US foreign policy, both economic and political.

I.f. Enhanced cooperation of 1970s and 80s:

In the long history of the Indo-US science and technology cooperation, the 1950s and 1960s characterized by positive aspect, the 1970s could be appropriately referred to as a decade of crisis. However the conditions improved in 1980s and witnessed very extensive co-operations in the field of high technology, such as computers, electronics, and communication in contrast to low visible cooperation of 1960s and 1970s namely in agriculture, animal husbandry, forestry and aqua-culture etc. Mrs. Indira Gandhi during her Prime Ministership showed much interest in fostering closer ties with the US, as she wanted to reduce India's over dependency on the Soviet Union. During her US visit in June 1982, she said at a press conference that, "I hope to clear up the misconception in US about India and also the image, that India completely in Soviet camp". The long standing disagreement involved in the supply of nuclear fuels to Tarapur plants resolved during this period. The most outstanding come out of the visit of Indira Gandhi to the US was the establishment of the Blue Ribbon Panel of Eminent Scientists from both the countries. [29]

[29] Cable & News Network (1982), "An Interview with Indira Gandhi" in *Time*, Accessed on November 19,2006, URL: http:// www.time.com/time/magari/article/v,9171,p.htm

Indo-United States Science and Technology Initiative (SIT):

The Science and Technology Initiative (STI) programme at that time included bilateral Research projects which concentrated on medical and economic applications. Although the focuses were on health, agriculture, meteorology, and solid state science, it had major sociological implications too. The standard of life in India showed signs of improvement due to American help in the health sector. The vaccination programme prevented premature death and increase the average life expectancy. During the periods of the Prime Minister Mr. Rajeev Gandhi, Science and Technology always remained as the main medium to modernize India. The immediate challenge for him was to over come obstacles to Technology Memorandum of Understanding (MoU) with the United States. Meanwhile in April 1985, the Indo-US sub commission on science and technology was set up to coordinate research activities and joint projects. In his successful visit to the US in June 1985 Rajeev Gandhi in his address to the US Congress hailed the Indo-US MoU as "beginning of a substantial partnership to our mutual benefit". He further said that "India needs new technology in a big way from the US which is per-eminently the land of high technology."[30]

Apart from the government and the Public Sector involvement in the Indo-US technology relations, the Private Sectors of the two countries were also given their due importance. In August 1985, the PACT (Programme for Advancement of Commercial Technology) was signed by Indian Ministry of Finance and the US Agency for International Development (USAID). It was mainly envisaged to collaboration in technology research and development between the Private Sectors of India and the US. To avail the essential funds, the US-India Fund

[30] Embassy of India (1983), "Indo-United States Science and Technology Relations: Harnessing the Potential" *Press Releases,* Accessed on 12th May 2006.URL: www.indianembassy.org/indousrel/sci.htm.

(USIF) was established in January 1987 to ensure continued funding for Indo-US cooperative activity in science and technology.

II.MILESTONES IN INDO-US SCIENTIFIC COOPERATION (NON-MILITARY COOPERATIONS)

1. India signed 'Point Four Agreement' with the US on December 28, 1950.

2. In 1955, fertilizer plant in Sindri and later on large fertilizer plants at Vishakhapatnam, Trombay and Madras were built by the US technical and financial help.

3. A spectacular enhancement of production of wheat and rice in Punjab and U.P, the result of combined efforts of Indian agricultural scientists, the US Government and institutions like Rock Feller and Ford Foundation, popularly called as *Green Revolution* in India during 1960s.[31]

4 In 1961, the Tarapur Atomic Energy Plant was constructed with financial loans of $80 million from the US Government, technical help from GE Company and assurance of supply of natural uranium by US Atomic Energy Commission.

5 In 1962, the Bokaro Steel Plant project was based on American financial aid and engineering supports.

6. The American Land Grant Agricultural Universities entered into partnership programme with Indian institutions to establish Agricultural Universities such as Punjab, Haryana, U.P, Rajasthan, M.P, Orissa Agriculture Universities, etc. [32]

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[31] Govindan Paragil, "The Green Revolution in India: A Case Study of Technological Change", in *Technology & Culture*, (Baltimore, John Hopkins University Press, October 1992), Vol: 33, no.4, p.737.

[32] Hadley Read "Partner with India: Building Agricultural Universities" in *Journal of Illinois College of Agriculture*, (Illinois, University of Illinois publications, 1974), p.142.

7. In 1972, agreement between Ford Foundation and Government of India, UNDP, ADB, led to the establishment of the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) in Hyderabad. The US government provided 25% of the budget of this and similar centers around the world.

8. Technical Institution like IIT in Kanpur, College of Engineering in Pune, College of Engineering in Guindy (Madras), Bengal Engineering College in Howrah, and University College of Engineering in Roorkee are the examples where a significant US contribution to Indian higher education was seen.[33]

9. In 1977, in areas of wildlife, a major Indo-US project at Keoladeo National Park in Bharatpur studying conflict between Wildlife habitat and human was under taken. *Project Tiger,* launched in 1973 was a cooperative venture of the Government of India and the US Wildlife Agencies, a comprehensive Eco-system conservation and development project providing healthier habitat for the tigers and it's pray, without any drastic artificial human interference.[34]

10. In 1978, India signed "health for all by the year 2000" funded by USAID and CARE to sets specific health goals. The eradication of smallpox in India in 1975 was due to combined effort of WHO and NIH.

11. In 1964, the first Indian Rocket launched from Nainital, was a result of combined effort of the Indo-US first collaboration in space. In 1974-75, NASA and ISRO took giant step with launching the project of Satellite Instructional Television Experiment (SITE). This early experiment in satellite communication provided broadcast of educational television programme to remote Indian

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[33] IIT(2005), Indian Institute Of Technology, Kharagpur, "Institute History", Accessed on 15yh November 2006. URL: www.iitkgp.ac.in/institute/history.php.

[34] David B. Sutton (1990), "Form Taj to Tiger" in Cultural Survival Quarterly (Online Edition), Accessed on 12th November, 2006.URL: www.culturalsurvival .org/membership/index.cfm.

villages. It is the precursor of Indian National Satellites (INSAT) later developed by endogenous technologies.[35]

III.ISSUES OF DISCORD IN INDO-US TECHNOLOGICAL RELATIONS

It was a fact that several irritants remained the Indo-US relations from time to time. However the focus here is on the specific matters of discord which had a marked bearing on the Indo-US technological relations. These may be categorized as following:

* Nonproliferation Treaty (NPT).
* Missile Technology Control Regime (MTCR).
* The Intellectual Property Rights (IPR) issues.

III.a NON PROLIFERATION TREATY: (NPT)

The NPT issue was perhaps the single longstanding issue of discord between India and the US. The persisting American and Indian variance over the NPT had considerable impact on several aspects of their bilateral relations. The transfer of technology from the US to India was one with major significance.

The diametrically opposite view of India and the US on NPT led to doubt in the US about Indian intentions and vice-versa. While India maintained its unequivocal position against Nuclear weapons proliferation, it was however committed for peaceful use of nuclear energy. Moreover India's geo-political

[35] Sundara Vadlamudi, "Indo-United States Space Cooperation Poised for take off? "in *Non-Proliferation Review* (Washington, Rovtledge Publication, 2005), Vol: 12, no.01.p.14.

position and strategic compulsions forced to keep its nuclear option open[36]. But the US considered India's non adherence to the NPT and also the conducting of peace full nuclear explosion test as matter of great concern.[37]

On the other hand, India had been supporting the motives of the US with regard to the NPT. According to India, the US was actively involved in championing the NPT worldwide, but consistently increasing or modernizing its own stockpile of nuclear weapons. The United States' position that it was doing so in its national interest and for maintaining the peace and security of the world was not convincing enough for India. The immediate fall out of the discord over NPT was the non-transfer of the US nuclear and relative technology to India. The suspension of supply of enriched Uranium to India was regarded as the beginning of the US hostility towards India. The Nuclear Non-proliferation Act (NNPA) was passed by the US Congress in 1978, with the objectives of preventing the export and sales of nuclear materials and technology. Similarly in 1985, the US declined to send CRAY XMP-24 Super Computers to India, expressing nuclear proliferation concerns. The US held that India's position on nuclear issue was ambiguous with regard to NPT. But other considerations were led to the US agreeing to sale sophisticated version of Super Computers to India.[38]

III.b.MISSILE TECHNOLOGY CONTROL REGIME (MTCR)

Since its coming in to force in 1987, the MTCR had been a subject of intense debate in India and the US. The MTCR was designated by the US to serve as an

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[36] Norman D. Palmer, *United States Foreign Policy and India* (New York, Prager Publication, 1984); p.222

[37] Ibid p. 225.

[38] Sandhya Sharma, "India and US: Technology Transfer and Foreign Policy." *Mainstream* (New Delhi, 3, October 1992), Vol: 30, No.51p.17.

adjacent to the NPT. The apparent of the US concern was over the possibility of the development of missiles and delivery systems which could carry nuclear weapons over long distances. The conditions placed on the transfer of missiles or related technology had been very restrictive. As a result dual use technology transfer especially those relating to space technology were adversely affected.

In the context of India, there had been a healthy collaboration with the US in the space sector during the Cold War years. The significant milestone in this direction was the Satellite instructional Television Experiment (SITE) and INSAT programme. The SITE was a collaborative programme under taken by the NASA of the US and Indian Space research Organization (ISRO) of India in 1974-75.[39]

As apart of the SITE, the US loaned the application technology satellite ATS-6 for educational programmer in remote Indian villages. This had been hailed as world's first direct broadcast satellite television system which provided a great impetus to India's space programme.

After the success of SITE, the Indian National Satellite (INSAT) project was under taken jointly. As par the Indian requirements the FORD aerospace and Communication Corporation in California designed and built the INSAT – IA and late INSAT-IB commercial satellites. These collaborative efforts, no doubt, had revolutionaries the Indian television and communication networks.[40]

Despite these constructive efforts, conflicts emerged ever since India lunched Integrated Guided Missile Programme (IGMP) in 1985. There after, the Intermediate Range Ballistic Missile (IRBM), Agni were successfully designed and demonstrated by India in 1988. Following that, the surface to surface medium range missile, Prithiv was commissioned. After the remarkable success

[39] Dinshaw Mistay, "India's Emerging Space Programme", in *Pacific Affairs* (Vancouver, 1998), Vol: 71, no.02, p.151-174.
[40] Sundara Vadlamudi , n.35, p.17.

of these missiles India developed Surface to Air missile, Akash and anti- tank missile Nag. India was also able to demonstrate the indigenous fabrication of satellite and had then lunched by NASA or through Soviet aerospace agency or the European Space Agency since 1982.

As far as the US was concerned, the simultaneous development of missile and satellite launch vehicle was contradicting India's position on peaceful application of space technology. So the US apprehension was that if India develop the satellite launching capability then it would must likely result in the fabrication of Inter Continental Ballistic Missile (ICBM) which might pose a threat to continental America. Apart from that the US felt that India might offer better deals to potential missile buyers and satellite launchers, which could affect the US business prospect in this field.

In 1990, Indian Space Research Organisation (ISRO) entered to an agreement with GLAVKOSMOS (Soviet Space Agency) for the supply of Cryogenic rocket engine to India. Immediately the US reacted sharply to this deal and slapped embargo for two years to ISRO and GLAVKOSMOS. In May 1982, India expressed its displeasure over the US action arguing that the Cryogenic engine was meant to be used for launching small satellites and not missiles. More over, Indian position was that the deal did not violate the MTCR norms. [41]

India was neither part of NPT nor of MTCR. Therefore, the US apprehension regarding proliferation concerns stood justified. But dialogue and persuasion had helped to clear the doubts to some extent in the US about India's position. Thus the issues concerning MTCR had been a determining factor in technological relation between the US and the India.

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[41] R.P Singh, "Missile Technology Control Regime : A Study of United States Technology Control Policy and Process," *Strategic Analysis* ,(New Delhi) Vol: 14 , No.4 , July 1992, p.1418.

III.c.THE INTELECTUAL PROPERTY RIGHTS (IPR) ISSUES.

Trade, Investment and Technology are complimentary to each other. Therefore any minor or major problems relating to these aspects would most likely to have an impact on the rest. In the case of India the dispute pertaining to trade was seen to have a distinct bearing on the transfer of technology from the US. India was being alleged to have violated the copy right and trade mark protection of the US products which were causing loss to the US industries. Blaming India for unfair trade practices, the US threatened action against it as part of the Super 301 clause of 1988 Omnibus Trade Act. [42]India was placed under the Priority Watch List along with Brazil and Japans. Such US action was expected to affect not only Indo-US bilateral trade but us investments and technology transfer as well. [43]

The first Bush administration was empowered by law to cut-off all trade and technology ties unless New Delhi compiled with the provision of the US trade act. However in June 1990, India was taken off the list. The reason of the US decision was not clear since India had refused to shift on the issue. But it is a fact that, large U.S business corporations had been applying pressure on the Bush administration – especially Pepsi co, which had been allowed in to Indian investment market. So the sprit behind this was not to antagonize India at a stage where it was steadily liberalizing its economy.

The US had been expressing its dissatisfaction over Indian patent laws. According to the United States, the Indian Patent Act of 1970 (IPA) had several shortcomings which were detrimental to the US economic interest. The US alleged that the Indian pharmaceutical industry violated patent restrictions

[42] Ronal A. Cass(1991), "Velvet first in Iron Gloves : The Omnibus Trade Act and Competitiveness Act of 1988", in *Regulation*, Accessed on November 20, 2006, Vol:14, no.01, URL: www.cato.org/pubs/regulation/reg/ynlc.html.

[43] Ibid

causing about $ 41 million loss to its pharmaceutical industries.[44] Similarly, the alleged soft ware piracy in India was matter of concern to the US. The US had been waiting India to give process patenting instead of product patenting which had been affecting the US pharmaceutical and software industries.

Since then both India and the US had been engaged in dialogues at various levels to resolve the thorny IPR issues. The US also had been demanding that India open up its insurance and investment market to foreign entrepreneurs.[45] India had been slowly liberalizing its economy and hence the US had not contemplated any harsh action in this respect too. In fact, the formation of World Trade organization (WTO) in 1994-95 (the successor of GATT) had helped in the arbitration process. Therefore, any controversy relating to Trade related Intellectual Property Rights (TRIPS) and Trade Related Investment Measures (TRIMS) between the US and India was expected to be settled by WTO. With such multilateral mechanism in force, unilateral action by the US against the members of the WTO vide Super 301 can't be enforced.[46] No doubt the discord over the sensitive IPR issues threatened to have impact on their technological relations. But no such problem ever reached a flash point to prove this proposition.

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[44] Tarun Kabiraj, "IPR , TRIP'S and Technology Transfer" in *Economic and Political Weekly*(Bombay, November 1994,) , Vol: 29. No.47, 19, , p.2993

[45] Citha D. Maass, "Reorientation of Indian Foreign Policy after Cold War", in *Aussen Politik*, (Hamburg), Vol: 44, No.1, fast quarter 1993, p.35-36.

[46] Kabiraj, n.44, p.2994.

IV. NEW COOPERATIONS IN THE FIELD OF INFORMATION AND TECHNOLOGY

Participation of developing countries with the US in technological cooperation was limited but has improved in recent years. The share of developing countries, especially South-East Asian countries in technology agreement was at 4.9 percent in 1980. This has increased to about 6.2 percent in 1990s. Even among those agreements, which involved developing countries, Information Technology related technology agreement dominated, and their share was as high as 27 percent.[47] The Indian share in domestic information technology and pharmaceutical industries rapidly increased in late 1990s and continued in new millennium. In the world market of software and hardware the capability of Indian IT industry is considered as both high and efficient. Among the technology cooperation agreements with the US, the knowledge intensive sectors like IT and Life Sciences industry alone constitute about 55 percent of all agreements. Information industry alone constitutes about 37 percent of such agreements. This tentative estimation based on some secondary sources show that alliance in IT sector is on the rise and the bulk of foreign alliance in Indian firms are mostly with US firms.[48]

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[47] A. Arora and S. Athraye "Software Industry in India's Development" in *Information Economics and Policy*, (Amsterdam, Elsevier publication, 2002), Vol: III, p.93.

[48] The size of Indian IT market was about US $ 5.6 billion in 2001, showing a growth of 40 percent over its size in 1990-00. The contribution of soft ware and service was about 36 percent in 2000-01.

It is shown that often enterprises have more than one alliance and with each alliance they work on multiple projects and partners. If we analyze the nature of these alliance it will appear that the linkage involved transfer of technology, sub-contracting, cross holding, marketing arrangement etc. To facilitate better analysis the alliance activities can be divided in to five broad categories: like technology related, production related, marketing and distribution related, and those involved in management agreements.[49]

A more detailed analysis of technology related linkage show that collaboration for establishing *standards* was dominant. Significantly more than 26 percent of the alliance involved joint research and development (R&D) agreement. Besides, many of the technology related alliance involved both joint R&D as well as collaboration for establishing standards. Thus, unlike other sectors , where technology links are typically dominated by licensing agreements, Indian firms in its IT and Telecom Sector are seen to be "more equal" partners in technology development processes.

The Capability Mature Model* (CMM) *Certification:

In 1998, the Department of Electronics, Government of India signed an agreement with Carnegie Mellon University (CMU), Pittsburg for collaboration in software process improvement technologies. Under this agreement, the Centre for Information Systems Engineering (CISE) of CMU works with the Indian Software Community to introduce software process improvement technologies

[49] Arpita Mukherjee and Paramita Deb Gupta "Prospects for IT Enabled Services Under a Indo-US FTA" in Working Paper ,*Indian Council For Research On International Economic Relations*, New Delhi 2003,p. 3

in India. This subsequently developed into a capability mature model (CMM) certification process where in CMU collaborated with the private sectors (through the appraiser programme) to upgraded processes quality among the Indian software firms. According to an estimate, in early 2002, out of the 58 "CMM level 5" firms in the world, 32 were based in India.[50]

CMM level 5 is the highest level of certification. The Indian software firms have caught the quality bug and are in the process of getting certified under several quality related programmes, including the CMM and the ISO. Of the top 300 software firms in India, 216 already had some kind of a quality certification by December 2001. Many more firms were in the process of being certified. Besides, many firms have multiple certifications. Interestingly, there have been cases when an American multinational has gone in for CMM quality certification in their Indian subsidiary first and later import those high quality practices back to its U.S. development centers. Thus , the quality related to the Indo-US collaboration has not contributed to the capability building among Indian software firms but there has been a *reverse flow of knowledge* embodied in quality related processes and practices from India to the US .

The Sankhya Vahini project[51]

In 1998, a MoU was signed for a collaborative venture between the Department of Telecommunications (DOT), the Department of Electronics, the Ministry of Information Technology, some premier Indian Educational Institutions (see table) and the Carnegie Mellon University (CMU) of the U.S. to launch a high speed data transmission backbone over a 10,000 km of optical fiber network. In

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50 Rakesh Basant "U.S – India technology cooperation and capability building" *in East-west Center Occasional papers,* Hawaii, East-West Center. 2004, p.23.Accessed on 3rd June 2006.
URL: www.eastwestcenter/.org/store/pdf/ECONup/053.pdf.

51 R.Basant and P. Chandra "Interfirm Linkages and Development of Capabilities in Indian Telecom Sectors", (Ahamadabad, Indian Institute of Technology, 2003).p.32.

the first phase of project, it was proposed to provide a speed of 2.5 gigabits per sec (Gbps), which was to be upgraded to 40 Gbps in the second phase. The project was to be executed by an Indian company Sankhya Vahini India Ltd (SVIL), in which the equity shares of the CMU and of the Indian government were not to exceed 49 percent. CMU was to participate in the venture through a firm IUNet (short for inter- university network) promoted by the university. The authorized share capital for the venture was expected to be RS 1,000 corers and the initial paid-up capital was pegged at RS 300 corers. The 45 percent equity share to be held by DOT was to be in the form of providing a pair of optical fibers from the existing optical fiber cables. IUNet's equity of 49 percent was to be essential in the form of equipment, system, technology and some cash. This project ran into some problems and was shelved in November 2001.

An interesting element of Sankhya Vahini project was that the Government of India recognized the need for a significant improvement in the communications infrastructure in India and decided to have a joint venture with a foreign firm created by the CMU instead of having the Conventional Transfer of Technology Agreement. Moreover, the participation of the Indian educational institutions in the project indicated the recognition of the fact that such participation facilitates the learning and technology diffusion processes.

__The creation of 'Media lab in Asia':__

The Government of India and the Massachusetts Institute of Technology (MIT) have one-year exploratory project to create the Media Laboratory of Asia (MLA), which is conceived as an independent, non-profit organization. The Government of India has committed of, US $ 12 million seed funding for the one-year programme, $ 1.7 million of which has been earmarked for MIT's participation. Based on the success of the first year, the two parties will enter into a 10-year agreement, during which they will collect funds worth $ 1 billion. Of this the Indian government may contribute about $ 200 million, while the remaining $ 800 million would be raised chiefly from the Indian and foreign corporate sponsors. The broad objective of MLA would be to facilitate the invention, adaptation and deployment of innovations to benefit all sectors of the Indian society, especially the poor sections. The idea is to take technology to the masses by making products that would enhance the quality of life in the country. A large variety of initiatives in entrepreneurship, health, disaster control, education, low cost computation technologies multilingual and multi-literate systems, and accessible telecommunications are being discussed.[52]

MLA was also an effort that initiated through collaboration between the Indian government and MIT but expected to expand into a collaboration that will involve public and private entities in both India and the US. The transition from "public-public" collaboration to one that involves both the public and private sectors were seen as critical for the success of the programme. This was a clear departure from the earlier standpoint of Indian government.

__The Programme of Advancement of Commercial Technology (PACT) Programme:__

In August 1985, an agreement was signed between USAID and the Government of India (GOI) to initiate a Programme of Advancement of Commercial Technology (PACT, USAID Program No. 386-0496). US $ 20 million were earmarked for this Ten-Year programme. ICICI was appointed as the implementing agency of the programme. The objective was to assist private sector companies in India and the U.S. for joint research and development projects. By 1995, PACT had assisted 50 projects and disbursed US $ 18.72

[52] R. Radhakrishnahn " Media labs Asia project, a Non Starter" The Hindu (Online Edition), Chennai, 12th November 2002. Accessed on 12th December 2006. URL:www.medialabsasia.org/index.php?option=content 4task=view&id=81.htm.

million. PACT was a technology development programme wherein the USAID and the Indian government facilitated coming together of Indian and the US firms for joint research. Broadly, PACT promoted two ideas: joint technology development by Indian and the US companies and external funding of R & D by venture capitalists or others. The project financed a total of 50 joint R & D projects. Of these 35 led to a commercial use of new technology, mainly in the US market. Through these joint R& D efforts, PACT also supported expansion of a number of high technology firms. Some of them turned out to be great successes. However, PACT was not a commercial success. It did not recover its costs through royalty payments. Many problems contributed to this failure. Still the spillover benefits of the PACT programme may have been significant. It is argued that the programmer's main contribution lay in creating an impetus for policy changes with respect to venture capital in relation to the Indo-United States technological co-operations.

The other significant spillover benefit has been that the success of PACT showed that linkages to international technology through links to the US firms were useful and not harmful, to national R&D capability development. Both firms and policy makers were able to see these advantages.

Types of Collaborations in Terms of Organizations Involved :(Table-1.)

Types of entities	***U.S Entities***		
Indian entities	Public / university	private	Both
Public / university	*Institution building:* (Indian Institute of Technology,Kanpur,Punjab Agriculture Universities) *Research / Action:* (Cornell-ICAR Germplasm Exchange, Vaccination) *Software Process Improvement:* (CMU and Centre for Information Systems and Engineering) Media Lab	US firms alliance with India educational institutes	Sankhya Bahini (Carnegie Mellon University, CMU,IUnet, Dept. of Telecom , BSNL, IIT Mumbai, and Indian Institute of Science, Bangalore, Indian Institute of Information Technology , Hyderabad)
Private	TCS links with CMU, University of California, Riverside / San Diego & University of Wisconsin.	Variety of inter-firm linkages.	CMM Certification, (CMU, private entities)
Both	TCS, Indian Institute of Science and UC, San Diego,	Midas, IIT (Chennai) and Analog devices.	PACT Programme Media labs.

Source: Rakesh Basant "U.S – India technology cooperation and capability building" in East-west center Occasional papers, Hawaii, 2004
URL: www.eastwestcenter/.org/store/pdf/ECONup/053.pdf.

Types of alliance	EXAMPLES
Services	
Staff Augmentation	Aditi-Microsoft
Application Development	GE-Satyam(JV)
Package Implementation	TCS-SAP
Migrations	Compaq India-Persistent Systems
Remote Maintenance	TIS-Silverline Technologies
ASP	Satyam Computer Associates(JV)
IT Enabled Services	Wippro-Spectramind (Equity)
Non-Service Industries	IBM-WIPRO
Computer Hardware	Satyam-CCMB
Biotechnology	Van Dorn Demag-Infosys
	Nortel Networks – Infosys
Verticals	Nordstrom- Infosys
Engineering Services	Swiss Air – TCS
Telecom and Internetworking	DCM Datasystems -Intel
Retail	Oncourse – Geometric Software
Finance	Wipro – HP
Aviation	Siebel-Infosys
Embedded Systems & chip design	Answer think-HCL
Manufacturing	
Systems Integration	
CRM	
Technology Consulting	

Variety of Alliances Entered in to by Indian IT Firms (table-2)

Source: Rakesh Basant "U.S – India technology cooperation and capability building" in East-west center Occasional papers, Hawaii, 2004

URL: www.eastwestcenter/.org/store/pdf/ECONup/053.pdf.

Chapter-3

SANCTIONS AND ITS EFFECTS ON INDO-US SCIENCE AND TECHNOLOGY COOPERATION

The main frame of Indo-US Science and Technology relations were broadly in the fields of Space, Computers and Agriculture. The sanctions imposed on India in the wake of test of nuclear devices by the United States is considered as the major hurdled in this cooperation. Still, the trajectory of Indo-US Scientific Cooperation had not been affected optimally, rather the major hiccups that had occurred in the function of cooperation was largely caused by political factors. In the eighties, the Cold War adversely influenced science and technological cooperation between the two countries. The issue of Cryogenic engines was a case in point. However, the 1998 tests by India invited the United States sanctions that were mandatory by its domestic laws. The use of sanctions was political. The United States efforts to cap reduce and rollback Indian Nuclear Programme and get India to adhere to the Non-Proliferation Treaty (NPT) had been nullified. Since, this was a stated goal of the United States foreign policy during Clinton years; the impositions of sanctions were inevitable.

I.IMPOSITION OF THE SANCTIONS

Following the detonation of nuclear devices in May 1998, the US imposed harsh economic sanctions upon the Government of India. This type of sanctions on science and technology had far reaching effects on Science and Technological Aspects of Indo-U.S relations. The United States sanctions on India were imposed according to the Arms Export Control Act, also known as the Glenn Amendment of 1994. The Act requires that the President impose sanctions against a "Non-Nuclear-Weapon" state if it "detonates a nuclear explosive device." India is considered a "Non-Nuclear-Weapon" state under the

International Proliferation Treaty until it is confirmed that it has a bomb. The sanctions had the following restrictions to be applied on India with immediate effect:[1]

(A) Termination of assistance under the Foreign Assistance Act of 1961, except humanitarian assistance in the form of food or other agricultural commodities [which includes the U.S. development assistance programmes and International Military Education and Training (IMET) programmes];

(B) Termination of (i) sales of any defence articles, defence services or design and construction services; and, (ii) licences for the export of any item on the U.S. Munitions List;

(C) Termination of all military funding;

(D) Denial of any credit, credit guarantees, or other financial assistance by any department agency or instrumentality of the US administration (such as the EXIM Bank, the Trade and Development Agency and the Overseas Private Investment Corporation), except humanitarian assistance;

(E) Opposition to the extension of any loan or technical assistance by international financial institutions (such as the World Bank, the International Monetary Fund and the Asian Development Bank);

(F) Prohibition of any U.S. bank making any loan or providing any credit, except for the purpose of purchasing food or other agricultural commodities; and

[1] Virginia I. Foran, "Indo-United States Relations after the 1998 Tests: Sanctions versus Incentives" in Garry K.Bertsch, Seema Gahlaut and Anupam Srivastav (eds), *Emerging India :US Strategic Relations with World's Largest Democracy* (New York: Routledge Publications,1999) p.62

(G) Prohibition of export of specific goods and technology, broadly termed "dual-use" items.[2]

The Arms Export Control Act does not impose a minimum or maximum amount of time for sanctions. In order to repeal the order, however, the President is required to notify Congress or Congress is required to issue a joint resolution calling for an end to sanctions. The U.S. made it clear that it wants India to accede to the Comprehensive Test Ban Treaty and the nuclear Non-Proliferation Treaty (NPT), which is signed by 149 countries, and to cease the testing of nuclear weapons. India has refused to sign the Comprehensive Test Ban Treaty (CTBT) arguing that the agreement, approved by the United Nations in 1996, works to the advantage of the world's known nuclear powers. India wants to renegotiate the CTBT. Notwithstanding the strong International pressure, the Indian government is anticipated to maintain its current position given that it has the popular support of its people on this issue. The Cable and News Network (CNN) reported that a poll indicated that 91% of urban Indians support the tests.[3]

India was mostly affected in the field of Economy and Science and Technology. Economically, suspension of all direct aid to India was $142.3 million a year approximately, excluding $ 91 million for humanitarian and food aid program. The balance of the $ 51.3 million was for a variety of development aid which was suspended.

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[2] "Dual-use" items are those that have both a legitimate commercial use and a military use in the development or production of advanced conventional weapons, or weapons of mass destruction.

[3] CNN(1998) Cable and News Network (Online Edition) June 18, "U.S. Outlines Sanctions Against India, Pakistan" .Accessed on 5 , November,2006 at URL:
http://edition.cnn.com/WORLD/asiapcf/9806/18/india.pakistan.sanctions/index.html

Weapon sales to India from the US, including technology that can be used to design and construct weapons, were also prohibited. This was small since most of India's weapons came from Russia. However, India was affected as the prohibition of weapons sales had a broader impact; it also included import of computer technology. [4]

II. IMPLICATIONS OF SANCTIONS:

II.a._Effect of sanctions on Science, Technology and Dual-Use items in India:

The Department's Bureau of Export Administration (BXA) of the U.S Commerce Department (DoC) denied export of dual-use items controlled for nuclear or missile nonproliferation reasons under the Export Administration Act to all end users in India and Pakistan. Apart from that there is an exception for commercial aircraft safety and maintenance equipment and for computers above 2,000 Millions Theoretical Operation per System (MTOpS) which was prohibited under the Export Administration Act for national security purposes. On a discretionary basis under the Export Administration Act, the United States will control all exports with a presumption of denial, including those not presently requiring a license, to a published list of Indian and Pakistani government entities involved in nuclear and missile programs. On the other hand, the United States also published a list of Indian and Pakistani government entities involved in military activities and will require a license, with a presumption of denial, for

[4] Dianne E. Rennack, Foreign Affairs, Defense, and Trade Division "India and Pakistan: U.S. Economic Sanctions" in *CRS Report for Congress.*, (Washington D.C, Congressional Research Service, The Library of Congress, February 3, 2003) p.2.

all items controlled by the Export Administration Regulations with the exception of common use item (those under category EAR99). In addition to this the United States government identified private entities. Supporting India's and Pakistan's nuclear or missile programs under the Enhanced Proliferation Control Initiative (EPCI).[5]

This would result in a broader licensing requirement for those entities with a case-by-case review of such licenses and a presumption of denial for transactions. Favorable consideration continued to be given to other dual-use exports, U.S. business relationships, and other arrangements providing benefit to the U.S. with private and public Indian and Pakistani entities.

Sanctions imposed by the US government after India's nuclear tests in May 1998 had hit work badly at the science installtions of india which were listed in the entities list of the United States government.Among them, the Tata Institute of Fundamental Research (TIFR), India's premier institution for physical and mathematical research in Mumbai was mostly affected. [6]

In accordance with the sanctions, the US government agencies were prevented from collaborating with the 250 scientific research institutions in india, and US firms require export licences to trade with them. The US government even stopped seven Scientists from the Fermi National Laboratory from attending an international conference on high-energy physics at TIFR.

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[5] United States Department of Commerce, Bureau of Export Administration (January 22, 1998), "United States Sanctions on Export of Dual-Use Goods to India and Pakistan", Accessed on 15 November, 2006 at URL : www.bxa.doc.gov /India-Pak.htm

[6] K. S. Jayaraman,"US Sanctions Hurt Basic Research in India" *Nature,* 11 February, *1999,(On Line Edition)* Vol.397(460), New York, Nature Publicing Group , Accessed On 15 November,2006 at URL: www.nature.com/nature /journal/v397/n6719/full/397460.htm

To access the extent of sanctions on scientific and technological research in India, a meeting was held in TIFR on 28th January 1999 with a large number of Scientists participating from all over India. Chemistry Prof. G. Krishnamoorthy, who organized the meeting, said that TIFR was suffering most from the denial of equipment and services from US firms. "The effects of sanctions began only after the publication of the entities list by the US Bureau of Export Administration in the middle of November," further, "we have received a large number of denials from companies because they apparently want to play it safe". A laser bought from Spectra-Physics at a cost of $250,000 in March 1998 for studying Biomolecules has been idle for months because the company was refusing to ship any attachments or to service it, despite a one-year warranty. A $100,000 computer bought from Silicon Graphics for solving complex problems in theoretical physics was lying unused, as the company has refused to replace defective processors. The work stations and servers bought from Digital are not being serviced. Sorvall has refused to deliver high-speed ultracentrifuges, among others Malaria researcher Shobhona Sharma said that Sigma (India) has been instructed not to supply chemicals or biochemicals. Optical and electronic components from Thorn Labs have been denied.[7]

Many Indian Scientists percived that the research equipments supplied before the sanctions are not working properly or has been stopped. "Where new purchases of materials and equipment have been denied, the ongoing research projects have either had to be abandoned or toned down," said Krishnamoorthy. Although some items can be obtained from other countries, it was impossible in

[7] R. Ramachandran "Sanctions: The Bark & Bite" in *Frontline* (Online Edition), Chennai 10 May, 1999, Vol.16, Accessed on 13 September, 2006 at URL: http://www.hinduonnet.com/fline/fl1610/16101100htm.

many cases. "Denial of products from the US would place us in a situation where we will not be able to select the best approach in our research." [8]

Scientists felt the sanctions have gone far beyond the stated purpose of limiting India's nuclear, missile and military activity and are hurting basic science. Some suspect that the heads of the country's scientific agencies are down playing the issue because of vested interests.

Apart from constraints felt in field of Research and Development, the Glenn Amendment also affected the flow of some sophisticated tehhnological know-how to India, which apparentaly handicapped some of ambitious projects. For example, the case of import of software and hardware related to information security or data encryption, restriction imposed on these items because this dual-use item was also a crucial role in development of chemical weapons. While this was important for E-commerce particularly in banking operations and also useful for intelligence operations, the single end-user referred to above could be the Ministry of Home Affairs or the Research and Analysis Wing (RAW) which were not directly affected by the sanctions. The import of chemical weapon precursors could be by chemical industries, which is permitted as India is a signatory to the Chemical Weapons Convention.[9]

As a result of sanctions, fairly high shares of license applications were denied. So as an impact of sanctions on Digital Computers it can be taken to be around $10 million annually.[10]

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[8] Ibid.

[9] P. Balaram "Sanctions", Indian Academy of Sciences (On Line Edition), Accessed on 15 November, 2006. URL: www.ias.ac.in/Currsci/May 10/Article 1.htm

[10] Latfulla Mangi "Sanctions: An Instrument of United States Foreign Policy" in *Strategic Digest*, New Delhi, Vol.28, No.7, pp.1119-23

In other instance, the Defense Research and Development Organisation (DRDO), the importer of Aero-engine and GE-404 worth $ 2.4 million for the Light Combat Aircraft (LCA) had been affected badly.[11] Non-availability of critical parts and components affected LCA, for which the U.S. was the chief source. The DAE, the DRDO and ISRO identified items that were difficult to procure from the U.S. and located alternative sources. About 200 items, worth $1 million, were identified and for about 10 percent of these, the U.S. seemed to be the exclusive source. Most of these were electronic items such as microwave and RF components, integrated circuits, high-performance electronic devices, oscilloscopes and other critical materials.[12] That was largely used for LCA.

From the perspective of R&D (Research and Development) institutions which figured in the Entities List (EL), and a small volume of specific high-tech instruments or high-performance goods and equipment caused difficulties. However, the effect of sanctions was mainly felt on specific high-value equipment such as the neutron generator, lithography equipment, and items, like a Squid magnetometer or a liquid helium plant. Overall, while it seemed that in value terms the impact may not be all that significant, but in terms of criticality of some items for a given programme and other intangibles, which cannot be estimated, the impact of sanctions may have been significant.

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[11] The Light Combat Aircraft (LCA) has been developed indigenously by Department of Research and Development Organization (DRDO), Government of India, which is dependent on American GE-404 engine. DRDO has a project going on to replace the GE-404 engine by Indian build "Kaveri" engine.
[12] R. Ramachandran, n.7.

The import of 'dual-use' items of India was subjected to Export Administration Regulation (EAR), which implemented by Bureau of Export Administration (BXA) of the U.S Department of commerce. On the following table the list of the applications that were considered as 'dual-use' values are illustrated;

LICENSE APPLICATIONS PROCESSES FOR INDIA DURING 1997-98

Export Commodity, Classification No.	Description	No. of Applications	Value (in Thousand Dollars)
EAR 99 Items	Subject to the EAR	427	59576
SE002	Technology for development/production/ use of information security	108	50013
5D002	Software for information security	25	27332
3A001	Electronic devices/components	68	9949
3A992	General purpose electronic equipment	54	1051
4A003	Digital computers	43	11398
3A292	Oscilloscopes	33	624
3A993	Electronic test equipment	33	1195
9A991	Aircraft and certain gas turbine engines	31	182
IC350	Chemical precursor	24	30203

- Source: U.S Department of Commerce Licensing Data Base, Available at www.chaos.fedwrld.gov/bxa/whatsnew.cgi/indiapakistan.pdf

II.b. Effect of sanctions on U.S.-India Trade and Commerce:

Prior to imposition of sanctions, bilateral trade and investment ties had been increasing as a result of Indian liberalization. In fact, the United States is India's largest trade and investment partner. In 1997, U.S. exports to India were valued at $3.6 billion, while U.S. imports from India totaled $7.3 billion. America's principal exports to India included aircraft and its parts, computers and its components, and chemicals. Principal imports from India included textiles, apparel, diamonds, and jewelry. The U.S. exports to India in 1997 were increased nine percent over 1996, and 81 percent in 1991, at the time India began its economic liberalization program. As of 1996, total U.S. investment in India was $1.1 billion.[13]

The ability of the U.S. companies to respond to new opportunities in India has been helped by the Commerce Department's trade promotion and advocacy activities before the imposition of the sanctions. It could be assumed that this was one of the thrusts that propelled the United States to ease the economic sanctions later. The imposition of sanctions and its removal had significant impact on the economic relations of the two countries. As the trade increased after 2001 it was cleared that technological services and items were also going to flow more smoothly. The effect of the deepening relations between India and the United States after 2001 also cascaded on science and technological issues. In particular the import of dual-use items became easier. Not only that it was also evident that sanctions ceased to be the instrument of United States foreign policy in the context of India and Pakistan given that they were both "strategic partner" and "critical ally" in the War on Terror. The strategic partnership envisaged by

[13] U.S Department of Commerce, Bureau of Industries and Security (1999) "India and Pakistan: Export Control Programme, Description and Licensing policy"Accessed On 15 November, 2006. URL:www.bis.doc.gov/News/Archieves99/Repts/Ipackum.pdf.

the United States with India infact had the effect of increasing the pace of removal of sanctions. While the politico-strategic motives and determinants that pushed the bilateral relations further. The neutralization of sanctions specifically aided the resumption of technological cooperation.

III.INDO-U.S SCIENCE AND TECHNOLOGICAL COOPERATIONS AFTER 2001

III.a. The Neutralization of Sanctions:

The decision of India and Pakistan to support the United States in its war against the Taliban regime, on war on terror prompted President George W. Bush to lift the nuclear sanctions imposed on them in the wake of their nuclear tests in May 1998. The announcement was made through a Presidential Determination (No. 2001-28), which was sent as a memorandum to the Secretary of State Colin Powell. Basically, President Bush has exercised to the full the nuclear sanctions waiver authority bestowed on the President by Congress in October 1999. Former President Bill Clinton had signed this waiver provision, which was part of the Department of Defence Appropriations Act, 2000 (DDAA2000), into law (Public Law 106-79) on October 25, 1999, and exercised the authority only partially on October 27, 1999. The exact scope of the lifting of sanctions was announced through a notification of the U.S. Federal Register. The removal of the sanctions has also resulted in a comprehensive review of the supplementary measures that were put in place in 1998 with regard to export controls on "dual-use" goods in the form of an Entity List (EL) and a corresponding export licensing policy. [14]

The export and re-export of "dual-use" technologies are subject to the Export Administration Regulations (EAR), which are implemented by the Bureau of Export Administration (BXA) of the U.S. Department of Commerce (DoC). This covers exports of goods from a country other than the U.S. as well. Such goods, if exported from the U.S., would be controlled by the EAR. An item not manufactured in the U.S. also attracts the EAR if it contains a minimum of 25 per cent of U.S.-made components.[15]

III.b._Bureau of Export Administration (BXA) and Technology Transfers:

The EAR controls export of goods and technologies to individual countries for reasons pertaining to nuclear proliferation, missile technology, national security, chemical and biological weapons, anti-terrorism measures and other foreign policy concerns. For its export licensing process, the BXA maintains a Commerce Control List (CCL), a classification of controlled goods. In implementing the sanctions under category (G), the BXA put in place an export licensing policy in June 1998. Under this policy, export licences for items controlled for reasons pertaining to nuclear proliferation and missile technology would be denied in the case of Indian and Pakistani end-users. Such items account for nearly 50 per cent of the so-called dual-use technologies.

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[14] Stephen Fidler and Edward Luce, "A Fine Line: The Bush Administration has Signalled that it Wants to Forge Closer Ties With India," *Financial Times*, London, June 1, 2001, p. 18.

[15] Department of Commerce, Bureau of Export Administration, "India and Pakistan: Lifting of Sanctions, Removal of Indian and Pakistani Entities and Revision in License Policy: Final Rule" *Federal Register (Part-IV)*, Accessed On 17 November, 2006 at
URL: http://chaos.fedworld.gov/bxa/whatsnews.cgi/indiapakistan.pdf.

In November 1998, the BXA instituted certain supplementary measures, including in the entities list over 300 government and private organizations in India and Pakistan that were deemed to be involved in nuclear or missile-related activities. The EL is maintained under the "end-use and end-user" prohibition clause (Supplement 4 to Section 744) of the EAR.

For the entities named in the list, a license was required for export of all items controlled by the EAR with a strong "presumption of denial". For all entities except military entities such as ordnance factories, this policy required an export license (with a presumption of denial) even for the EAR99 items - the basket of routine, non-dual-use, non-sensitive items, which do not figure in the CCL and which normally do not require a license.

III.c. Sanctions and High-Performance Computers (HPCs):

The export of high-performance computers (HPCs) is governed by a separate HPC Policy under the EAR, which had classified destinations into four tiers. India is in Tier 3. (Tier 4 is the most restrictive, with complete denial of HPCs.) At the time of the imposition of the sanctions, the rating for HPC in terms of Composite Theoretical Performance (CTP) was 2,000 million theoretical operations per second (MTOPS) - the performance of a Pentium PC - and above. The sanctions and the EL implied that computers with a CTP rating of above 2,000 MTOPS would be denied for the named entities. However, in July 1999, the threshold was increased from 2,000 to 6,500 MTOPS (roughly the performance of a 950 MHz Sun workstation with four processors). Since then, the license exception limit for end-users that are not on the EL has been increasing every six months as part of Clinton's HPC policy. And, since January 2001, such organizations have been allowed to import without license systems that have a CTP rating of up to 85,000 MTOPS (roughly a 64-processor Sun system). [16]

III.d. The Brownback Amendment:

In October 1998, the U.S. Congress passed the India-Pakistan Relief Act (IPRA) - the Brownback Amendment - which gave the President the authority to waive part of the sanctions. The nuclear sanctions of May 1998 were imposed in pursuance of Section 102(b) (2) of the U.S. Arms Export Control Act (AECA) - the so-called Glenn Amendment - which mandated the following:

(A) Termination of assistance under the Foreign Assistance Act of 1961, except humanitarian assistance in the form of food or other agricultural commodities (which includes U.S. development assistance programmes and International Military Education and Training (IMET) programmes);

(B) Termination of (i) sales of any defence articles, defence services or design and construction services; and, (ii) licences for the export of any item on the U.S. Munitions List;

(C) Termination of all military funding;

(D) Denial of any credit, credit guarantees, or other financial assistance by any department agency or instrumentality of the U.S. government (such as the EXIM Bank, the Trade and Development Agency and the Overseas Private Investment Corporation), except humanitarian assistance;

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[16] Ibid.

(E) Opposition to the extension of any loan or technical assistance by international financial institutions (such as the World Bank, the International Monetary Fund and the Asian Development Bank);

(F) Prohibition of any U.S. bank making any loan or providing any credit, except for the purpose of purchasing food or other agricultural commodities; and

(G) Prohibition of export of specific goods and technology (broadly termed "dual-use" items).[17]

This authority was valid only for a year and was limited to sanctions under categories (A), (D), (E) and (F). Clinton exercised this authority on December 1, 1998, and waived sanctions under the categories of (A), (D) and (F) for both the countries. Significantly, he also waived the sanctions against Pakistan under category (E), which mandated the U.S. to oppose loans from International Financial Institutions.

The following are the vital aspects of DDAA2000 waiver authority of October 1999:

1. As against the one-year waiver period earlier, the new waiver was applicable without any time-limit unless either India or Pakistan conducted fresh nuclear tests.

2. Unlike the IPRA, which specifically excluded waiving of sanctions under categories (B), (C) and (G), the new Act gave the President the power to waive these too if "he determines and so certifies to Congress that the application of the restriction would not be in the national security interests of the U.S."

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[17] Ibid.

On October 27, 1999, Clinton exercised this authority in a limited way. In the case of India, he waived the sanctions under (A), (D) and (F); and for Pakistan, the waiver was only in respect of (F) and the extension of credit, credit guarantee or other financial assistance provided by the U.S. Department of Agriculture under (D) for purchase of food and other agricultural commodities.[18]

The DDAA2000 also included the "Sense of the Congress" that called for "Targeted Sanctions".[19] It said: "Export controls should be applied only to those Indian and Pakistani entities that made direct and material contribution to weapons of mass destruction and missile programmes and only to those items that can contribute to such programmes." As a consequence, the EL was revised twice, in December 1999 and in July 2000. The first revision removed 51 Indian entities (mostly Ordinance Factories, the Tata Institute of Fundamental Research and the Saha Institute of Nuclear Physics) from the EL and the second removed two (the Uranium Recovery Plant and the Nuclear Science Centre) and added one (the Indian Space Research Organization's Telemetry, Tracking and Command Network, or ISTRAC). No Pakistani entity had been struck off the EL until then. Further, in March 2000, the licensing policy towards Indian and Pakistani entities was changed with regard to EAR99 items, with the presumption of denial becoming presumption of approval.

The lifting of sanctions per se has done nothing to the EL, which follows entirely from the EAR. However, in the wake of the removal of the sanctions and in keeping with the "Sense of Congress" expressed in DDAA2000, the BXA and the State Department have, in separate exercises, pruned drastically

[18]David A. Dismuks, "Export Control Policies and National Security: Protecting United States Interest in the New Millennium" in *Texas International Law Journal*, 1999, Vol.34, No.2, pp. 173-85.
[19]U.S Department of Commerce,n.13

the EL for both India and Pakistan. The final revised EL was announced in the Federal Register notification of October, 2000 first. Significantly, all Academic Institutions and Private and Public Firms and a large number of units of the three Strategic Departments - Defence, Atomic Energy and Space - have been removed from the EL.[20]

The licensing policy of the BXA for EAR-controlled items too has undergone a significant change with the removal of the sanctions on "dual-use" goods. According to a statement issued by the BXA, the current policy of "presumption of denial" for items controlled for reasons of nuclear proliferation and missile technology will now become a policy of "case-by-case review" for all end-users except those on the EL for whom these items will be denied. For entities on the EL, other items not related to nuclear proliferation and missile technology, including the EAR99 items, would continue to require a license. However, instead of the current policy of "presumption of denial" for non-EAR99 items, it would be a case-by-case review process. For EAR99 items, the policy of "presumption of approval" will apply.[21]

III.e.Sanctions and Light Combat Aircraft (LCA):[22]

High-technology and strategic programmes such as the Light Combat Aircraft (LCA) and the Advanced Light Helicopter (ALH) got slowed down because of the non-availability of parts and components from the U.S. The LCA programme was hampered because the Indian-designed Flight Control System

[20] R. Ramachandran," Out of Blacklist" in *Frontline* (on line edition), accessed on 25 November 2006 at URL: http://www.hinduonnet.com/fline/fl1610/16101500htm.
[21] Ibid.
[22] Rahul Bedi ,"Technical and Cost Problems Stall India's LCA" in *Jane's Defence* Weekly, 4 February, 2000 (on line edition), Accessed on 25 November, 2006 at URL: www.janes.com/defence/air_force/news/jbw000204_01_n.htm.

(FLS), which was sent to the U.S. for evaluation, was held back owing to the sanctions against re-exports. The FLS were released later. Similarly, the ALH programme suffered because of the denial of licences for the export of engines for the aircraft. More significantly, with the development of the Kaveri engine for the LCA lagged way behind schedule, the first fleet of LCA that would be inducted would require GE404 engines. Now, with the lifting of the sanctions, these can be imported.

III.f. Sanctions and Defense Equipments:

The Indian Navy's fleet of Sea King Helicopters had grounded after the British firm suspended product support following a directive from the US State Department. However, Bush Administration had determined that some specific US-made components from the U.S. Munitions List [forbidden by Sanctions (B)] could be exported for the purpose of refurbishing the Sea King Helicopters of India. With the complete removal of sanctions, such routine maintenance of defense equipment can now take place. The Indian Army too had suffered - which was evident during the Kargil-War, because of the denial of export of weapon-locating Radars from the U.S. as well as Europe. Now these equipments became available.[23] As the discussions above illustrates, the issue of technology transfer which was a major cause of friction between India and the United States began to witness a sea change as the political context change.

The first level of change in the science and technological cooperation between India and the United States began as the United States contemplated a

[23] Global Security Organization, "Indian Navy: The Key Target of United States Pressure" The Islamic Republic News Agency. Accessed on 15 November, 2006 at URL: www.globalsecurity.org/wmd/library/news/india/2001/india_irna.htm.

different level of relationship with India after the demise of the erstwhile Soviet Union. It was given concrete shape by the Clinton administration's initiatives.

However, the next level was stumped by Indian Nuclear test of 1998. Yet within a year of it, the Clinton administration revives the dialogue to find a way around the nuclear issue. His visit to India 2000 actually laid out both a vision and an Institutional frame for the two countries to follow. Indian policy and position also reflected a similar change. Both in the geo-political as well as in the bilateral context, the two countries were moving close to each other. The impetus to a faster pace in cooperation came after the 2001 in the wake of 9/11. Bush administration decided to "inject substance" into the relationship by adopting a two-pronged strategy. Faster removal of sanctions and establishment of institutions like High Technology Cooperation Group (HTCG) and Next Step in Strategic Parternership (NSSP) etc. accurately accessed the problems and move forward.

CHAPTER-4

DEEPENING OF THE S&T COOPERATION SINCE 2001: *THE NSSP* AND BEYOND

I. INDO-US COOPERATION IN HIGH TECHNOLOGY: THE HIGH TECHNOLOGY COOPERATION GROUP (HTCG)

Trade in dual-use items also referred to as strategic trade, was one of the core issue of contention between the United States and India. American sanctions on India in the wake of nuclear tests specifically prohibited a large number of items and related technological know-how, as US feared that India may utilize them in making some conventional weapons of mass destruction or long range ballistic missiles. However, as India joined the US in its so called war on terrorism, the sanctions were lifted. Both the countries had expressed their strong desire to see progress in the area of strategic trade, as well as in civilian space and civilian nuclear matters. So a procedural framework had been strongly needed not only to by pass the constraints of export control, but also to enhance the cooperation to an optimal level. Trade related benefit of both the countries was considered. The major thrust behind these steps.

I.a. The High Technology Cooperation Group (HTCG) Framework, Objectives and Procedures:[1]

The High Technology Cooperation Group or HTCG was formed in 2002 to provide a standing framework for facilitating and promoting the U.S.-India high-technology trade and building confidence for trading in sensitive items. The

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[1] David H. Mc Cormick, Under Secretary of Commerce for Industry and Security, "India and the United States: An Emerging Global Partnership" in *Speeches and Remarks-2005*, Accessed on 15 November 2006. URL: www. U_S_ Embassynewdelhi/ David H_ McCormick /Indi.htm

goals the United States and India outlined in the HTCG's 2002 inaugural session were: to lower the barriers to trade, to increase access to high-technology goods, to enhance nonproliferation measures, and to encourage private industry participation in the dialogue. In addition to facilitate the strategic trade, the HTCG also includes the trade in the field of Information Technology, Bio-technology, Defense Technology and Nanotechnology between the United States and India. After the formation of the HTCG both sides agreed that the HTCG should have two primary and interrelated objectives:

The first was to strengthen nonproliferation through enhanced dual-use export control cooperation. This cooperation would, in turn, build confidence for greater bilateral trade in dual-use goods and technologies. The second was to develop and promote high-technology trade more broadly by focusing on cooperative steps both sides can take to create the appropriate economic, legal, and structural environments necessary for successful high-tech commerce.

Moreover the HTCG has been specifically formulated to deal with the following issues of trade between the two countries:

- Tariffs on Information Technology products that, despite recent reforms, are still high enough to impede high-technology trade;
- Customs procedures that inhibit high-technology trade;
- Ways in which the United States and India can work together to promote the development of e-commerce; and
- Ways in which the United States and India can work together to ensure that all stakeholders develop a flexible, internationally compatible approach to data protection.

I.b. The Guiding Principles

The first guiding principle behind this kind of arrangement was the burgeoning Indian economy and the volume of its foreign trade with America. India's full GDP in 2004 was the 10th largest in the world, and its growth rate for 2005 through 2006was expected to be over 7 percent. India's exports to the world have increased from $ 49 billion to nearly $ 80 billion and purchasing power has increased as well, so that it is now importing almost twice the amount of goods it was three years ago. The U.S. exports to India have increased dramatically - nearly doubling in three years from only $4.1 billion in 2002 to almost $8 billion estimated this year. Yet only a small percentage of that trade is controlled. Approximately one percent of the U.S. exports require a license. Of those exports in sensitive items that do require a license, 91 percent were approved in fiscal year 2005.

Secondly, the spread of democracy has paved the way for the expansion of global free markets, where economic freedom and political freedom are as one. India and the United States are committed to establish a free trade relationship that ultimately brings prosperity to both the countries.

Third, the technology revolution continues to change the world at unprecedented speed. Today, the United States and India exist a world apart, yet with the decline in cost of communication and transportation, geographical distance is no more a barrier. However, difficulties remained as Kenneth Juster remarked:

> "Unfortunately, many of the same technologies that have changed the world for the better also pose a threat of being used by terrorists and rogue nations against us. Accordingly, implementing and enforcing strong export controls to combat the proliferation of these technologies is more important today than ever before. Finally, the realignment of the global political environment has reshaped our world. The end of the Cold War, the ongoing war on terror, and the market forces that have emerged in Asia have dramatically altered the globe - economically, strategically, and socially. Because of these trends, the U.S.-India relationship is more important today than it has been ever before." [2]

Since 2001, the United States and India have experienced a historic transformation in relations. The remarkable changes in the past few years, culminated in the 18th July, 2005 Joint Statement, in which President Bush and Prime Minister Singh declared their resolve to continue to transform the relationship between the two nations and establish a global partnership. This Joint Statement also declared that the completion of the Next Steps in Strategic Partnership (NNSP), launched in January 2004, would provide the basis for expanding bilateral activities and commerce in space, civil nuclear energy, and dual-use technology. It was remarkable that in only two years, the two countries were able to create the foundation for cooperation in areas that had been off limits less than a half a decade ago.[3]

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[2] Kenneth I. Juster, Under Secretary of Commerce, for Industry and Security "Stimulating High-Technology Cooperation with India", speeches at *Annual Meeting of the U.S.-India Business Council, New* York, June 2003. Accessed on 1December, 2006 at URL:www.usindiabusiness/speech_Kenneth_Juster/June_2003/NY.htm.

[3] Adam Ereli, Deputy Spokesman, Bureau of public affaires, "United States-India Joint Statement on NSSP", (2004) *Press Releases, US Department of States*, Accessed on 16 November,2006 at URL:www.state.gov/r/pa/prs/ps/2004/36290.htm.

I.c.Components of the HTCG

Defense Trade

In the 18th July, 2005 Joint Statement, President Bush and Prime Minister Singh expressed their satisfaction with the New Framework for the U.S.-India Defense Relationship, signed by the U.S. Secretary of Defense Rumsfeld and Indian Defense Minister Pranab Mukherjee in June as a basis for future defense technology cooperation. In addition, the Framework included the creation of a new group - the Defense Procurement and Production Group - or DPPG. The main emphasis was to be given on protection of sensitive military items.

In the past, the HTCG private sector participants have spoken extensively about ways to enhance defense trade. In November 2004, the HTCG agreed to form a U.S.-India Industry Working Group on Defense Technology, which convened in February 2005. The completion of the Next Steps in Strategic Partnership (NSSP) in July 2005 addressed many concerns related to export licensing policies and procedures, including a commitment to streamline the U.S. licensing policies and remove certain end users from the Department of Commerce Entity List.[4]

All of these meetings have shared a common theme of more communication, more clarity in the procurement-policies of both the United States and India, and more transparency in how procurement decisions are made. The participating industries also outlined more detailed insights and recommendations to provide a useful foundation for the government-to-government dialogue.

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[4] US-India Business Council,(2005) "HTCG Dialogue on Defence Technology, Data Privacy, and Export Licensing", Accessed on 1 December,2006 at
URL: www.usindiabusinees/HTCG/feb2005/NY.htm.

Biotechnology

Similar to defense technology, Life Science and Biotechnology have been a focus of the HTCG since its inception. There is significant growth potential for Biotechnology in India. India has made tremendous progress in its infrastructure development, technology base and range of production capability for biotechnology. Yet there is much that can be done to increase opportunities in this area, for example, supply chain integrity of biological and pharmaceutical materials and expanding clinical research capacity in India. As noted by private sector meetings in the past, the protection of data and Intellectual Property Rights also remain a concern for many the American companies.

Nanotechnology

In the area of nanotechnology, there are numerous issues related to the societal, ethical; regulatory that affects this exciting new technology. Now a major objective of the HTCG is the role of export controls in nanotechnology, which is a subject that many governments throughout the world - not just the United States - are attempting to examine. Areas of potential cooperation include the development of meteorology techniques and appropriate nomenclature to enable the further international development. Moreover patent issues related to Nanotechnology are also a subject that the group must be look at today through its functioning for the future.

I.d. The Successes of the High Technology Cooperation Group (HTCG):

As a result of this understanding since 2002, India has far greater access to the U.S. technology as the U.S. has loosened controls on certain dual-use items. In addition to this, the United States has also lowered the average processing time for licenses for India. So while total U.S. exports to India have increased licensed dual-use exports have declined, as fewer technologies now require a license.

In the area of the U.S. policy changes, the HTCG has fostered the exchange of information that has reduced confusion over export policies and procedures on both sides, benefiting the two governments, as well as the private sectors. With the removal of some Indian end users from the U.S. Entity List, more American high-technology items may be exported to India without a license for civil-space and civil-nuclear end uses. The HTCG has also contributed critical support for India's export controls. The passage of the landmark Weapons of Mass Destruction (WMD) law establishing an export control system was a major achievement and a clear indicator of India's commitment to nonproliferation and the U.S.-India relationship.[5]

The last joint meeting of HTCG was held between President George Bush and Prime Minister Dr. Manmohan Singh on July 18, 2005. In this joint session, the achievements of HTCG were accessed as follows:[6]

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[5]Rajya Sabha (2005), "The Weapons of Mass Destruction and Their Delivery Systems, Prohibition of Unlawful Activities Bill", Parliament of India, Synopsis of Debates (online web). Accessed on 13th November 2006 at URL: http://164.100.24.167/rsdebate/synopsis/2005/2082005.htm

[6]Bureau of South and Central Asian Affairs, Department of States,(2006) "The India-U.S Economic Dialogue" *Fact Sheet,* Washington. DC, March2, 2006. Accessed on 2 December, 2006 at URL: http://www.state.gov/p/sca/rls/fs/2006/62493.htm. Also see.

U.S Embassy, New Delhi. "U.S.-India Joint Statement on High Technology Commerce," *Press Releases* .Accessed on 2 December, 2006 at URL: http//www.jointstatement/hightechnologycommerce /U_S_ Embassy N.htm

• Only 1% of the U.S. exports to India require a license and over 90% of license applications were approved in FY 2005;

• Processing time for dual use application has dropped by 25 % to 34 days on average;

• More than half the value of controlled dual use trade to India no longer requires a license as a result of NSSP implementation, and trade in high technology items is expected to significantly expand in the coming years;

• Increased private sector interaction with the two governments, including industry events under the HTCG auspices and outreach activities targeting business communities in both the US and India. This has helped in promoting bilateral high technology trade;

• The contribution of the private sector Working Group on defense technology, which has helped in better understanding and in forging bilateral cooperation in this sphere.

II. INDO-US STRATEGIC COOPERATION IN SCIENCE AND TECHNOLOGY: THE NSSP

The Next Steps in Strategic Partnership (NSSP) initiative was launched in January 2004, allowed the US to open a dialogue and build trust on a number of sensitive areas, including high-technology trade, civil nuclear cooperation, space, and Missile Defense. Started in January 2004, President Bush and Prime Minister Vajpayee had issued a joint statement declaring the inauguration of NSSP. This initiative took its shape from the prolonged demands of Indian government to ease the restrictions imposed on India by United States after India tested its indigenous nuclear weapon in 1998.[7] In other words, NSSP can be dubbed as the institutional setting between the US and Indian government to pass over the sanction in procedural manner with a series of reciprocal steps. At the beginning, the NSSP consisted of three areas in which cooperation would be sought, namely-- civilian nuclear activities, civilian space programs, and high-technology trade, which were called as 'trinity'. Moreover, the two countries agreed to expand dialogue on Missile Defense to make the NSSP covering of 'Quartet'. The successful completion of the Next Steps in Strategic Partnership is an important milestone in the transformation of the relationship between the United States and India. In particular, completion of the Next Steps in Strategic Partnership would enable the United States to expand the scope of bilateral commercial satellite cooperation. It removed the U.S. export license requirements for unilaterally controlled nuclear items to most end users, and revised export license requirements for certain items going to the safeguarded civil nuclear power facilities.[8]

The Next Steps in the Strategic Partnership (NSSP) initiative launched by President Bush and Prime Minister Vajpayee to build trust and cooperation in areas of the greatest sensitive to two nations - civilian nuclear technology, civil space technology, high-technology trade, and a dialogue on missile defense. Important progress has been made in each of these areas, and more is expected with the completion of Phase II of NSSP in the near future. This expanded Strategic cooperation in the fields of high technology cooperation, prevents the

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[7] G.Balachandran, "Indo-U.S Relations: Perception and Reality", *Strategic Analysis*, New Delhi, vol. 29, No.2, April-June 2005, p.201.

[8]Robert J. Joseph, Under Secretary of Arms Control and International Security, "Hearing on U.S-India Civil Nuclear Cooperation Initiatives", Prepared Remarks Before *Senate Foreign Relations Committee*, Washington, DC, November, 2, 2005. Accessed on September 14, 2006 at URL:http://www.scoop.co.nz/stories/WO0511/S00078.htm.

proliferation of weapons of mass destruction. The creation of a working group was to expand contact between two space organizations, and other security related areas taking advantage of respective technological advantages, such as missile defense. To combat the proliferation of weapons of mass destruction, relevant laws, regulations, and export-related procedures have been strengthened, and measures to increase bilateral and international cooperation in this area were instituted. These cooperative efforts were undertaken in accordance with the respective national laws and international obligations. Congressional role in the shifting nuances of the United States technology cooperation with India was significant. This was a major change in the legislative hurdles and challenges faced by the United States administration with regard to its Indian policy.

The following is the joint statement of Indian Prime Minister Manmohan Singh and the President of United States Bush on the completion of NSSP on July 18, 2005.

> *"India and USA resolve to transform the relationship between their countries and establish a global partnership. As leaders of nations committed to the values of human freedom, democracy and rule of law, the new relationship between India and the United States will promote stability, democracy, prosperity and peace throughout the world. It will enhance our ability to work together to provide global leadership in areas of mutual concern and interest."*[9]

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[9]The Hindu, (20 October,2005) "Joint Statement between President George W. Bush and Prime Minister Manmohan Singh, July, 18, 2005"(.Online issue) Accessed on 20th November 2006 at URL:www.hinduonnet.com/2005/10/02/Stories/2004/002055,htm

This visit of the Indian Prime Minister heralded the completion of the Next Steps in Strategic Partnership (NSSP) initiative, launched in January 2004. The two leaders agreed that this provided the basis for expanding bilateral activities and commerce in space, civil nuclear energy and dual-use technology. The perception of the Bush administration of India's role in the new global order remained at the core of the discussions on the NSSP.

II.a. Major Mile stones that Leads to NSSP

RUN UP TO THE NSSP:

The signing and successful completion of NSSP was not a sudden shift in the US foreign policy towards India. The erosion of export controls on India began nearly as soon as they were imposed. Following India's May 1998 underground nuclear tests, President Bill Clinton placed sanctions on India. However, merely a day after imposing sanctions, the U.S. Department of Commerce approved the sale of computer software for designing printed circuit boards to Bharat Dynamics Limited, a known missile maker. On October 21, 1998, the U.S. Congress authorized the President to waive the existing economic and financial sanctions against India and Pakistan for up to 12 months. By February 1999, citing a more flexible policy on India and nuclear nonproliferation, the Clinton administration relinquished objections to India's request for a $150 million World Bank loan. By October 15, 1999, Congress adopted an amendment to the Defense Appropriations bill that granted the U.S. President the authority to waive all sanctions against India.[10]

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[10] United States Department of Commerce, Bureau of Export Administration (January 22, 1998) "United States Sanctions on Export of Dual-Use Goods to India and Pakistan, Accessed on 15 November, 2006. URL : www.bxa.doc.gov /India-Pak.htm

Clinton never had the occasion to take this next step of eliminating sanctions. Instead, President George W. Bush did it for him. In October 2001, Bush waived sanctions placed on India following the 1998 tests. By November 2002, India and the United States agreed to set up the High Technology Cooperation Group (HTCG), a body to facilitate the transfer of sophisticated civilian and military technology and to discuss space and nuclear cooperation. Following its establishment, former Under Secretary of Commerce Kenneth I. Juster lauded the HTCG's contribution to the United States was 90 percent approval rate for dual-use licensing applications for India in 2003, more than doubling the value of such approvals to $57 million. This organization soon became a part of the larger India-United States Next Steps in Strategic Partnership (NSSP) initiative begun in January 2004. The NSSP assumed the function of expanding the U.S.-India cooperation in civilian nuclear activities, civilian space programs, and high-technology trade, leading to modification of the United States' export licensing policies. By May 31, 2005, the U.S. Energy Secretary Samuel Bodman and the Deputy Chairman of India's Planning Commission, Montek Singh Ahluwalia, had formed five working groups and nuclear technology exchanges under the "India-U.S. Energy Dialogue." Discussion topics are anticipated to include "fusion science and related fundamental research topics," which would ostensibly not require approval under the U.S. Department of Energy's regulations for "fundamental" technology transfer. Still, fusion technology may also be used to create an energy boost for nuclear weapons, allowing the same destructive yield with a smaller size and weight of deployment. Finally, in a decidedly overt military development, India's Defense Minister Pranab Mukherjee and United States Defense Secretary Donald Rumsfeld signed a 10-year defense agreement entitled "New Framework for the U.S.-India Defense Relationship" on June 27, 2005, just prior to the U.S.-India joint statement. This agreement called for expanding the bilateral defense trade including technology transfer, as well as joint research and developments.

MARKERS ON THE ROAD TO NSSP:

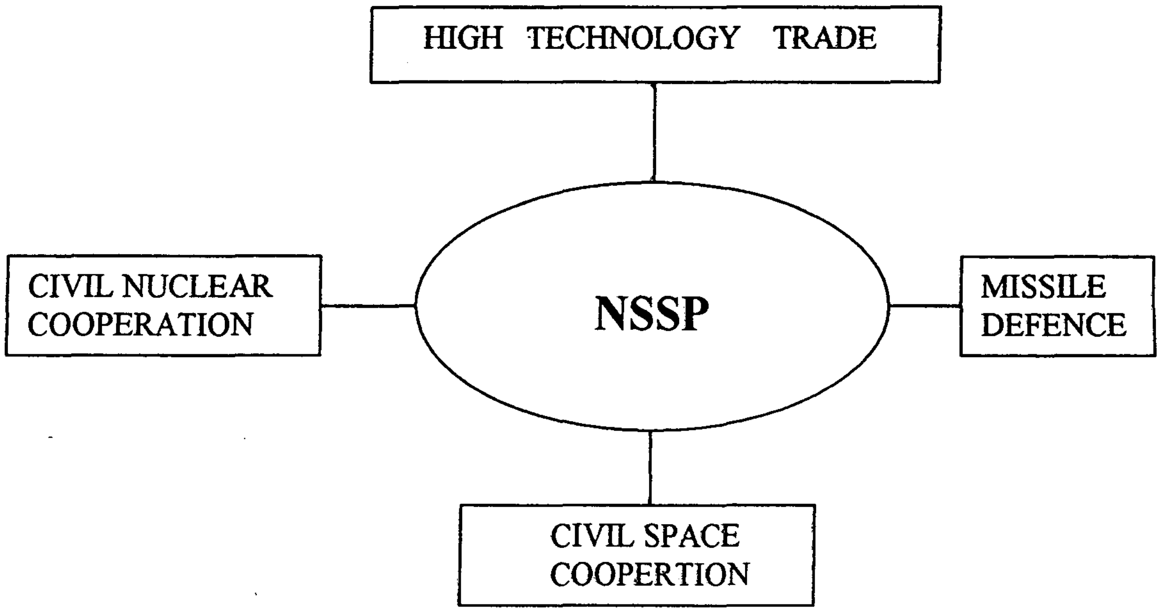
- In November 1984, in post Indira Gandhi -Regan meeting at Cancun, a MoU was signed between India and the US for providing 'CRY' computers to Indian Meteorological Department (MID), which was considered as the first dual use item US supplied to India.[11]
- The US instigated multilateral denial regimes, motivated by some Indian missile programmes, particularly after the revelation of the link between the Indian Space Research Programme (ISRO) and Integrated Guided Missile Development Programme (IGMDP).
- In March 1988, the implementation procedures of the MoU were detailed, but the MoU, is effectively dead after testing of "Agni".
- New sets of severe sanctions were imposed after May 1988 Nuclear Test in Pokhran.
- From 1998 to 2000 about 13 round of dialogues were take place between Indian External Affairs Minister Jaswant Singh and his counter part Talbot.
- In November 2001, the Indian Prime Minister and the US President met in Washington, D.C and agreed in partnership statement to take steps to "qualitatively transform the US-India relations". Agreement to discuss ways to stimulate bi-lateral High Technology Commerce.
- In November 2002, India and the US announced the establishment of High Technology Trade Group (HTCG)—first such set up by the US with any country.

[11] Raju G.C Thomas, "U.S Transfers Dual-Use Technologies to India" in *Asian Survey*, University of Californian Press, September 1990. Vol: 30, No. 9, p.827.

- In February 2002, the US and India signed "statement of principles on US-India high technology cooperation".
- In July 2003, the first meting of the HTCG was held at Washington. It was agreed that India and the US have to concentrate on broad industry sector: Information Technology (IT), Bio-Technology, Nano-Technology and Defence Technology. Action plans covered *inter alias;* Policy Review for Dual- Use Exports, End Use Verification, and Indo-US Bilateral Export Control Programme etc.
- In August 2003, the US adds 'Missile Defence' in to the trinity programmes of the NSSP.
- On January 12, 2004; the NSSP was announced by the Indian Prime Minister and the US President with covered the 'quartet' of: Civil Space, Civil Nuclear, High Technology and Missile Defence.
- On September 17, 2004, the 'End Use Visit Arrangement' documents were signed.
- On September 22, 2004, the US notified the revision of licensing policy.
- On 18th July 2005, the NSSP concluded with the Manmohan Singh - Bush joint statement.

II.b. Components of NSSP

The following figure illustrates the core components of NSSP:



II.b.1 High-Technology Trade

More recently, the U.S. Commerce Department officials have sought to dispel "trade-deterring myths" about limits on dual-use trade by noting that only about 1% of total the U.S. trade value with India is subject to licensing requirements.[12] Moreover, the great majority of dual-use licensing applications for India are approved (more than 90% in FY2005).[13] July 2003 saw the inaugural session of the U.S.-India High- Technology Cooperation Group (HTCG), where officials discussed a wide range of issues relevant to creating the conditions for more robust bilateral high technology commerce. Since 1998, a number of Indian entities have been subjected to case-by-case licensing requirements and appeared on the U.S. export control "Entity List" of foreign end users involved in weapons

[12] United States Department of Commerce, n.10.
[13] G.Balachandran, n.7, p.205.

proliferation activities. In September 2004, as a part of the NSSP implementation, the United States modified some export licensing policies and removed the Indian Space Research Organization (ISRO) headquarters from the Entity List. Further adjustments came in August 2005 when six more subordinate entities were removed. Indian entities remaining on the Entity List are four subordinates of the ISRO, four subordinates of the Defense Research and Development Organization (DRDO), one Department of Atomic Energy (DAE) entity, and Bharat Dynamics Limited, a missile production agency.[14]

II.b.2. Civil Nuclear Cooperation

As part of the high technology trade, the civil nuclear cooperation was seen by both sides as a major break through in that dialogue. While several studies have examined the pros and cons of the indo-United States nuclear deal from both the India and the United States perspectives, both the governments move forward purposefully on this aspect of NSSP. Correctly interpreting that successful complication of this cooperation would change the prospects of future indo-United States relation, governments on both sides put the deal as a crucial pivot to their respective domestic law maker. Even as the negotiations were going on, a cascading debate went on in both the countries wit almost all stakeholders from academia, think tank and opinion maker forcefully examining the gains and loses for the two countries.[15]

India's status as a non-signatory to the 1968 Nuclear Nonproliferation Treaty (NPT) has kept it from accessing most nuclear-related materials and fuels on the international market for some 30 years. New Delhi's 1974 "peaceful

[14] FSA (1999),Federation of American Scientists, "India-Pakistan Sanctions Clarification"(On line edition) Accessed 5,December 2006 at URL: www.fsa.org/news/india1999/April20Clarify.htm

[15] M.N Srinavasan (2006) "Indo-U.S Nuclear Deal Infringes On Our Independence" in *Rediff News (Online Edition)*. Accessed on 15th November, 2006 at URL: www.rediffnews.com/news/2006/aug/14ndeal.htm

nuclear explosion" spurred the U.S.-led creation of the Nuclear Suppliers Group (NSG) — an international export control regime for nuclear-related trade — and the U.S. government further tightened its own export laws with the Nuclear Nonproliferation Act of 1978. The July 2005 U.S.-India Joint Statement notably asserted that, "as a responsible state with advanced nuclear technology, India should acquire the same benefits and advantages as other such states," and President Bush vowed to work on achieving "full civilian nuclear energy cooperation with India."

As a reversal of three decades of the U.S. nonproliferation policy, such proposed cooperation is controversial and would require changes in both the U.S. law and in NSG guidelines. India reciprocally agreed to take its own steps, including identifying and separating its civilian and military nuclear facilities in a phased manner and placing under the international safeguards. The U.S Congress expressed concern that civil nuclear cooperation with India might allow New Delhi to advance its military nuclear projects and it will be harmful to broader U.S. nonproliferation efforts.[16] The Bush Administration previously insisted that such future cooperation with India would take place only within the limits set by multilateral nonproliferation regimes. The Administration now actively sought to adjustments to the U.S. laws and policies, and has approached the NSG to adjust the regime's guidelines. As per the initiatives of the NSSP, the US applied a "presumption of approval" policy for all dual-use items not controlled by the Nuclear Suppliers Group (NSG), if subject to International Atomic Energy Agency (IAEA) safeguards. Permitting the export of all the U.S. origin items not controlled by the NSG to the "balance of plant" portion of

[16] Robert J. Joseph, Under Secretary of Arms Control and International Security, "Hearing on U.S-India Civil Nuclear Cooperation Initiatives", Prepared Remarks Before *Senate Foreign Relations Committee*, Washington, DC, November, 2, 2005. Accessed on September 14, 2006 at URL:http://www.scoop.co.nz/stories/WO0511/S00078.htm.

safeguarded facilities will expand the scope of civilian nuclear cooperation between the United States and India.[17]

The two countries showed bilateral efforts to expand ties in a number of key areas, notably announced successful completion of India's nuclear facility separation plan. After months of complex and difficult negotiations, the Indian government presented a plan to separate its civilian and military nuclear facilities as per the July 2005 Joint Statement. The separation plan requires India to move 14 of its 22 reactors into permanent international oversight by the year 2014 and place all future civilian reactors under permanent safeguards.[18]

II.b.3. Civil Space Co-operation:

India has long sought to access the American space technology. Such access has been limited by the U.S. since the 1980s as to great extent international "red lines" meant to prevent assistance that could benefit India's military missile programs. India's space-launch vehicle technology was obtained largely from foreign sources, including the United States. It forms the basis of its intermediate-range Agni ballistic missile booster, as well as its suspected Surya intercontinental ballistic missile program.[19] The NSSP called for enhanced the U.S.-India cooperation on the peaceful uses of space technology. Moreover, the July 2005 Joint Statement called for closer ties in space exploration, satellite navigation and launch, and in the commercial space arena. As a step to ease the restrictions on Indian space programme, the US government removed licensing requirements for low-level dual-use items (known as EAR99 and XX999 items)

[17] Varghese Koithara, "India-U.S. Defence Cooperation" in *Economic and Political Weekly*, Mumbai, August 6, 2005, vol: XL No.32, p.3585.

[18] Ibid, p.3586.

[19] George Iype (2005) "Inside India's Newest Missile Project" in Rediff News (Online Edition). Accessed on 24th November, 2006 at URL: www.rediff.com/news/2005/oct/18geo.htm.

exported to ISRO subordinate entities that were on the Entity List. This change in licensing policy is expected to reduce the number of applications submitted for exports to ISRO subordinate entities by approximately 75-85 percent and reduced the total number of applications for all dual-use exports to India by approximately 20-25 percent.[20]

During President Bush's March 2006 visit to India, the two countries committed to move forward with agreements that will permit the launch of the U.S satellites and satellites containing the U.S. components by Indian space launch vehicles and two months later, they agreed to include two American scientific instruments on India's Chandrayaan lunar mission planned for 2007.[21]

III. THE IMPLICATIONS OF THE U.S.-INDIA STRATEGIC PARTNERSHIP

The successful completion of the NSSP has many important implications for India. Officially, it has been stated that both India and the United States have initiated steps toward transforming India into a "major world power in the 21st century".[22] While the joint U.S.-India statement issued on July 18, 2005 (the day NSSP's completion was declared) represents a significant step forward in

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[20] A.Bhaskaran, "Export control Regimes and India's Space and Missile Programme" in *India Quarterly*, New Delhi, Vol:58, No. 3-4, p. 206

[21] ISRO (2006), Indian Space Research Organisation, "India's First Moon Mission: The Chandrayaan-1", Announcements, Accessed on 20th November. 2006. URL: http://www.isro.org/Chandrayaan-1 /announcements.htm

[22] Condoleezza Rice, Interview with *India Today*, march 21, 2005, Accessed on November 15, 2006 at URL: http://www.indiatoday.com/itoday/20050328/

strategic bilateral relations, it has presented to the critics, an equally significant step backward in nonproliferation norms.

Although some high ambitious pursuits, such as a permanent seat in the United Nations Security Council for India , which was most widely mooted at that time did not come to fruition , still India made major gains in one area of particular access to dual-use technology. It is hoped by the Indian side that nuclear technology will lift India's masses to a better access of electricity and energy security. [23] Further rocket technology is expected to offer India's space program a giant leap forward, despite the prior American fear that, this same equipment and technology has another possible function, that of serving as a means to build a better bomb or a longer range missile. As the US authorities clarified, they were well satisfied that although India remains outside of the NPT, as well as outside the Nuclear Suppliers Group and the Missile Technology Control Regime, it has not been plagued with the widespread proliferation scandals that sully its neighbor Pakistan. [24]

In April 2005, India passed its Weapons of Mass Destruction and their Delivery Systems (Prohibition of Unlawful Activities) Bill.[25] Many of India's recent technological advancements, especially in the nuclear field, have been indigenous. This is exemplified by India's construction on the 500 MW Prototype Fast Breeder Reactor in October 2004 and reprocessing of mixed uranium and plutonium carbide fuel in its Fast Breeder Test Reactor at Kalpakkam in June

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[23] Richard G.Lugar "Hearing on U.S-India Nuclear Energy Cooperation: Security and Non-Proliferation Implications" Senate foreign Relations Committee, U.S 109th Congress, Session1st, November 2 , 2005., Washington DC, USGPO, p.4.

[24] Condoleezza Rice, n 22.

[25] Rajya Sabha (2005), "The Weapons of Mass Destruction and Their Delivery Systems, Prohibition of Unlawful Activities Bill", Parliament of India, Synopsis of Debates (online web). Accessed on 13th November 2006 at URL: http://164.100.24.167/rsdebate/synopsis/2005/2082005.htm

2005. While largely self-sufficient, India continues its pursuit of technology to advance its nuclear and rocketry programs forward. The United States, for its part, has chosen to tread into the supplier territory that it once admonishes Russia for entering.[26]

The joint U.S.-India statement creates a political quagmire in which strategic and economic bilateral gains affect the international community's nonproliferation momentum. In terms of the United States' part of the bargain, the decision to sign a 'Science and Technology Framework Agreement' for joint research and training and public-private partnerships posits the U.S. provision of high-technology to India. These transfers could extend to any number of exchanges previously banned under the U.S. sanctions and export control legislation.

Both sides agreed to build closer ties in space exploration, satellite navigation and launch and in the commercial space arena through mechanisms such as the 'U.S.-India Working Group on Civil Space Cooperation'. Yet, space technology also doubts for missile technology and the U.S. suspected advances could be used in enhancing India's pursuit of Intercontinental Ballistic Missile (ICBM) and submarine-launched ballistic missile capabilities. The United States also pledged to work to achieve "full civil nuclear energy cooperation and trade" with India, seeking Congressional adjustment of the U.S. regulations. Specifically, the July 18 joint statement mentions fuel supplies for safeguarded nuclear reactors at Tarapur. Tarapur is under International Atomic Energy Agency (IAEA) safeguards. However, more than a dozen of India's nuclear reactors, heavy water production facilities, enrichment plants, and uranium purification sites are not. Full civil nuclear cooperation lends itself to dual-use

[26] G. Balachandran, n.7, p.209.

dangers given the near impossibility of separating between civilian and military nuclear facilities and India has already selective approaches to the safeguards.

India demonstrated its commitment on both of these counts since plutonium used in its initial 1974 nuclear detonation originated in its Cirus reactor, supplied under a civilian use pledge. Even if India fulfills its pledge to place a few more civilian facilities under IAEA safeguards, the *Indian Express* stated it best in exclaiming that India would retain its "nuclear jewels" and keep Cirus, Dhruva and other weapons-related nuclear reactors away from inspectors. Moreover, full civil nuclear energy cooperation with a non-signatory to the NPT contravenes the very essence of the treaty.[27] India's promise to continue its unilateral moratorium on nuclear testing is already exists in practice. Similarly, in promising to refrain from the transfer of enrichment and reprocessing technologies to non-nuclear weapon states, India is merely reiterating its current stand and does not represent new initiatives. In promising to work with the United States for the conclusion of a multilateral Fissile Material Cut off Treaty (FMCT), India has furthermore promised to work toward a treaty that is yet to come to conclusion. As experts argue while the United States has relinquished many of its former policies, India has merely restated its own.

III.a. THE AMERICAN STAKES AND INTERESTS:

While the July 18, 2005 joint statement in terms of technological gains is weighted in India's favor, this does not indicate that there are no advantages for the United States. The United States benefit rest in the financial gains to be made through military sales to India and the preferential placement of the U.S. military

[27] C. Raja Mohan (2005) "Three Meat Grinders for Nuclear Deal: U.S Congress, NSG and IAEA", *The Indian Express. (Online Web)*. Accessed on 5th December, 2006 at URL: http:// www.indianexpress.com/story/1842.html.

bids vis-à-vis European, Israeli, and Russian competitors. The Indian Air Force plans to purchase 126 new jets over the next four to five years. Not coincidentally, on March 25, 2005, the United States agreed to allow Lockheed Martin to sell F-16 fighter planes, which may be used to deliver nuclear weapons, to both India and Pakistan. If F-16s are selected over Swedish, Russian, and French competitors, the total price tag for supplying India alone could reach $3 billion.[28]

Strategically, the United States offers the potential for increased cooperation with a country that is rapidly growing as an economic and military power in a region increasingly dominated by China. The United States has also been searching for a means of expanding the Proliferation Security Initiative and interdiction into the Indian Ocean. On issues of terrorism, India has also presented itself as a point of intelligence sharing in a crucial region.

Among the negative points for the United States, many of India's gains demand few if any new requirements. India remains outside of the nonproliferation regime. Cooperation on dual-use technology may one day threaten regional and international stability since India will be gaining access to missile and nuclear technology that could be used in an ICBM or for expansion of improvements in its nuclear weapons program. [29]

While India does not have a reputation for proliferating to other countries, it remains a source of concern for its own capabilities and for its impact on other states wishing to proliferate. The United States nonproliferation

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[28] Sukumar Muralidharan, "Partnership and its Discontents", *Economic and Political weekly*, Mumbai, August 6, 2005, vol: XL, No.32, p.3589.

[29] Joel Brinkley "U.S Nuclear Deal With India Criticized by G.P.O. in Congress" in *New York Times*, (online edition) October 31, 2005. Accessed on 3,December, 2006. URL: http://www.nytimes.com/2005/10.31/politics/31diplo.html?emc=eta1

principles and arguments used vis-à-vis Iran and North Korea will become more tenuous.

In fact, on July 25, 2005, just a week after the U.S.-India joint statement, Pakistan's Foreign Office Spokesman Naeem Khan voiced his government's interest in the U.S. cooperation on nuclear energy, high technology and the peaceful use of space technology. Ominously, that same week, Pakistan's Prime Minister Shaukat Aziz cancelled his visit to the United States. Russia and China were criticized in the past for their assistance to India, Iran, and Pakistan's nuclear programs. However, the U.S.-India joint statement opens up the playing field for future transfers to more countries than just India.

III.b. THE INDIAN INTERESTS:

Several Indian domestic news papers criticized that India has sold out to the US. Opposition to this was mainly led by BJP and its former Prime Minister AtalBihari Vajpayee and leftwing of the UPA government. On the whole, the removal of sanctions and mitigation of dual-use restrictions work in India's favor. India will gain access to technology that will enhance its civilian nuclear and space programs, as well as its nuclear weapons and missile fields. Not only it will access expand, but India's market and negotiating leverage will grow vis-à-vis Russia, ~~Israel, France and~~ other suppliers. Russia and France have already voiced approval of the United States' broad lifting of constraints on trade with India, hoping soon to be able to provide fuel and technology for India's nuclear, space, and defense programs. An increased U.S. presence also creates an incentive for China and other states to engage India further economically, politically, and militarily to prevent the U.S from becoming India's primary partner.[30] The cooperation in the nuclear and missile realm will spill over into all areas of trade and economic cooperation with India.

On the negative side, India will be losing a degree of its non-alignment policy, and its military policy will face greater U.S. interference. The U.S.-India alignment, even if only nominal, could lead to other countries regarding India as a U.S. ally. This newfound role will limit India's ability to intervene as an international player, especially in areas of nonproliferation. Not only will it be seen as a U.S. "ally," India will also serve as a shining example of to what some countries would aspire, establishing a nuclear weapons program outside of the NPT and later receiving acceptance and rewards. India may also wind up fulfilling the dire predictions of Indian analysts that see the United States attempting to dominate the Indian Ocean. India has escaped nonproliferation constraints and tested nuclear weapons. Yet, less than a decade later, India receives benefits in not only in the military realm, but also in nuclear and missile-related dual-use technology. This sends a hypocritical message to countries playing by the nonproliferation "rules," as well as to those that are trying to break them.

The U.S.-India joint statement has already set in the mechanisms that promise to test the U.S. Congress and the Nuclear Suppliers Group as to their stand on nonproliferation. In the meantime, the United States has tied its hands on demanding more concrete pledges from India on cutting its fissile material production, placing its nuclear facilities under feasible safeguards. The United States stopped just short of calling India a nuclear weapons state and yet it conferred upon India the same benefits as an NPT signatory.

[30] Daryl G. Kimball, "U.S-India Nuclear Cooperation : A Reality Check", *Arms Control Today*, September 2005, Vol: 35, No. 7, p.3.

The cooperation between the United States and India has the potential to generate economic and strategic benefits for both parties in military exchanges and confidence-building measures. However, the scale is decidedly tipped in India's favor on technology transfers. India is on its way to becoming a great power in the 21st century, and large part of this accomplishment will remain vested in its nuclear weapons and missile programs. Ultimately, while the U.S.-India joint statement is bilateral in tone, its repercussions will be global. Nuclear weapon states and military suppliers such as Russia, China, and France are carefully observing the outcome to guide their own future sales.[31] Similarly, countries outside of the NPT or countries contemplating violation of the treaty are also watching. It can be concluded that the recent successful signing of Indo-US nuclear deal has set in motion both international, regional and bilateral changes. It is note worthy that the United States congress passed the Export Control Bill with broad bi-partisan support. How exactly the two countries will work out the details of the cooperation remains to be negotiated. What is relevant here is the new face of the indo-United States technology cooperation, despite the rough road travelled, has the potential to deepen the indo-United States ties in forthcoming years.

[31] G. Balachandran, n.7, p.211.

CONCLUSION

Science and Technology have affected society and government for thousands of years, but the relationship has never been more important than it is today. Policymakers and economists continue to see science and technology as an engine of economic growth. In advanced industrialized countries like the United States, S&T has been shown to contribute significantly to economic growth and productivity enhancement. Technological progress has become an expected way of life and, public support for research and development has continued to grow because of wide spread recognition that scientific and technological progress is crucial for economic and military security. How ever science and technology are accused of no longer aiding the search for good life, but instead depriving people of their natural rights--nuclear arms threatens life, toxic wastes or chemicals are polluting the environment and cloning technology playing with ethics of god etc. So it is inevitable not only to promote scientific temper and technological progress but also to control or regulate it that ensures technology must not trespass in to its negative values. As a result "a policy for Science and Technology" or "Science Policy" developed which may be defined as " *a government course of action intended to support, apply or regulate scientific knowledge or technological innovation.*"

The range of policies that deals with science and technology is too broad for a concise general theory about how they are made. Science and technology policy includes the realm of energy, health, defence, transportation; education and national security etc. More over, the consequences of scientific and technological advances are now transcending the national boundaries. So the formulation of science policy is a complex process which involves both the legislative and the executive branches of the country.

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United States of America may be considered as the first country which brought up a precise and articulated framework of policies meant for science and technology. How the policy making is undergoing and how it adjusted itself in response to different world situations is briefly described in the first chapter of this study. As the Science and Technology issues are rarely a Democratic or Republican issue, party leadership is counted as a week cohesive force in the United States Congress. Also as policy making in science and technology requires expertise in the respective knowledge, which is alien to most of the legislators, the issue of expertise, is the core problem the Congress faces. However the President has some distinct advantages over the Congress in the use and manipulation of Science and Technology policy. By the virtue of the very nature of his power, the Presidents of the United States developed formalized and identifiable institutions (like Office of the Science and Technology Policy or OSTP and President's Science Advisory committee or PSAC) for obtaining scientific advice. [1]

The science policy making in the United States became more crucial because, after the Cold War, issues involving Science and Technology have moved to the forefront of the international diplomatic agenda .It is now considered central to Department of State's bilateral and multilateral interactions with other governments, as Science and Technology become integrated in to the United States foreign policy. So Science, Technology and Foreign policy are now considered as essential triangles of policy making.

On the other hand International collaboration replaced other models as the preferred method of building scientific capacity in developing countries. The international transmission of technological know-how and technological expertise is

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[1] Richard Barke; "Understanding Science and Technology" in *Science Technology and Public policy*, (New Delhi: Affiliated East west Press Pvt. Ltd, 1986), p.59.

growing and it is increasingly important in the world economy today. The weight of science- based commodities is constantly increasing in world trade, and trans-border scientific and technological cooperation is absorbing more energies and resources of governments and firms. International collaboration takes a number of forms, including sharing of research data, joint experimentation, conferences and other meetings, building of databases, standards-setting, and equipment sharing etc.[2]

While collaboration among developed and developing countries were once referred to as "North-South" or "donor-host" relationships, regional groupings or unequal partnerships no longer adequately describe global relationships in S&T. Once the science and technological capability was limited to a few wealthy countries, but today it can be now found in more than 50 countries of the world. Although legal boundaries are a ready method of classification, relying on nation-states as a grouping for scientific activity does not represent the whole picture. Often, a world-class capability exists in what would otherwise be called a developing country. To some extent the economically developed countries may depend on a less developed country for accessing cheap human resources or scoring other geo-political goals. For exemplifying these assumptions we can consider the Indo-United States science and technological cooperation as a case study.[3] .

Before we take a glance to this relations, we have to get acquainted with the aspect of science and technology policy and its role Indian Foreign policy since

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[2] Daniele Archibugi and Carlo Pietrobelli, "The globalisation of technology and its implications for developing countries: Windows of opportunity or further burden?"in Technological *Forecasting and Social* Change (*Science Direct)*, (Amsterdam, North-Holland Publication, 9 December,2002) vol:70, No.2003, p.862.

[3] Caroline S. Wagner, Irene Brahmakulam and Brian Jackson, "Science and Technology Collaboration: Building Capacity in Developing Countries." in *RAND Science and Technology: A Project for World Bank*,(Pittsburgh, RAND Publication, 2001),p.IX

independence. In relation to the US the functioning of a definite science policy and its institutional settings in India is vague from the very beginning. Many administrative units with overlapping functional powers like Committee on Science and Technology (COST) and Scientific Advisory Committee to Cabinet to (SACC) were developed to carry out the science policy. However after the passage of an articulated policy document known as the *Scientific Policy Resolution* in 1958, the aim and objective of the science and technology in India was clearly sought out.

The Indo-United States technological cooperation is considered as most successful and longstanding cooperation in the world. This relation has experience many highs and lows during different world situations. Even though it is the world's largest democracy, India has had a troubled relationship with the United States. Washington has tended to view Indian matters through the Cold War and nuclear-non proliferation lenses. The focus has restricted many aspects of the relationship including government to government relations, trade, and cooperation on strategic objectives and international arms control. India's policies on non-alignment , its close association with the former USSR, its restriction on foreign investments and imports, and its expectations of technology transfer and licensing rights have further narrowed the scope of relations between two nations that otherwise might have found common grounds in their shared experiences of colonialism, democratic values, and heterogeneous society. When the United States imposed sanctions against India in 1998, India was not seen in Washington as an essential and cooperative part of the solution of major international problems. Rather India was viewed as one of the problem, outside the non-proliferation treaty and an obstacle to U.S non-proliferations internationally. The Science and Technology cooperation is mostly affected by this kind of negative development in the relations.

To accelerate the move and by pass other constraints in technological cooperation, institutional settings like Next Step in Strategic Cooperation (NSSP) and High Technology Cooperation Group (HTCG) were formed. While the United States was allured by the economic opportunities, India saw the enhanced cooperation as a chance that will make India a technological superpower lifting its status within the developing countries and to provide its people privileged facilities based on superior technology e.g., The U.S satellite data are now used by Indian Meteorological Department .

The technology cooperation between India and the United States has the potential to resolve some longstanding differences. Theoretically high-technology cooperation can stimulate the Indian economy, and it is consistent with the traditional Indian development policy. Ultimately, it could contribute to building the trust needed for a more consistent relationship with the United States. For high technology cooperation to succeed, India must prefer improved relation with the United States over traditional statements and on sovereignty issues alone. New Delhi would have to accept the benefits of step-by-step approach to improving relation with the United States rather expecting mature high technology trade cooperation that requires the immediate undoing U.S non-proliferation legislation. The United States would have to judge that India's need for the U.S capital and high technology to invigorate a liberalized economy overshadows the desire of some to use those resources for furthering India's power projection and nuclear weapon capability. The feasibility of these objectives being achieved simultaneously depends on two factors: the ability of political leadership and domestic coalition within both countries to generate public and official support for short term benefits of high technology cooperation and long term benefits in improving the Indo-United States relations. It is evident from the perusal of high technology trade between the two countries with the Congressional passage of the new law regarding the civilian nuclear deal. The supporters of this deal have relied on the perspective that the cooperation between the United States and India has the potential to generate economic and strategic benefits for both parties in military exchanges and confidence-building measures. However, the scale is decidedly tipped in India's favor on technology transfers. India is on its way to becoming a great power in the 21st century, and large part of this accomplishment will remain vested in its nuclear, weapons and missile programs.. Ultimately, while this type of development is bilateral in tone, its repercussions will be global. Nuclear weapon states and military suppliers such as Russia, China, and France are carefully observing the outcome to guide their own future sales. Similarly, countries outside of the NPT or countries contemplating violation of the treaty are also watching. It can be concluded that the recent successful signing of Indo-US nuclear deal has set in motion both international, regional and bilateral changes. It is note worthy that the United States Congress passed the Export Control Bill. With broad bi-partisan support. However most of the restrictions had been lifted with time either due to changed global scenario or result of economic and strategic advantage of both the countries. How exactly the two countries will work out the details of the cooperation remains to be negotiated. What is relevant here is the new face of the indo-U.S technology cooperation, despite the rough road travelled, has the potential to deepen the Indo-U.S ties in forthcoming years. It is also clear that science and technology cooperation between the two, which has taken a faster pace since 2001, is going to be a central focus of the bilateral negotiation and agreement. Thus the relevance of the high technology cooperation can be regarded as major determinant in the deepening of indo-US ties.

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