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1 August, 1993

CERTIFICATE

This is to certify that the thesis entitled, INDIA'S PERSPECTIVES ON DEVELOPMENT COOPERATION WITH THE FEDERAL REPUBLIC OF GERMANY AND UNITED STATES, submitted by Ms Veena Ravikumar for the award of the Degree of Doctor of Philosophy of Jawaharlal Nehru University is her own original work. This has not been published or submitted to any other University for any other degree. This may be forwarded to the examiners for evaluation.

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Preface

Since its independence, India, has been engaged in the gargantuan task of its economic and social development. It has succeeded in realizing its set objectives only to a limited extent: As a result; today it bears two facets. On the one hand, it could take legitimate credit for having built up the world's third largest reservoir of scientific and technological skills, and also for having founded a structural base for its take-off as a modern industrial nation. But then, paradoxically its other side is gravely pathetic. It continues to be rated by the World Bank as one among the low income grouping of the Third World nations, with its forty per cent of the population living below the poverty line, and sixty-six per cent continuing to be illiterate. Is it not sad that even after fortysix years of its independence the question how to raise the physical quality of life of its populace continues to baffle its statesmen and scholars alike, and it also remains a subject intensely debated in different world fora?

However, now in the early 1990s, India has taken a bold initiative at liberalization of its economy with a view to intergrating it with the global mainstream. It is a bit late in the day. It is only after the failure of statism in the former USSR and Eastern Europe that India sought to shed its illusion of socialistic pattern of society, and move on the track to privatization and de-regulation of its economy. As yet the response from the developed countries has not been so encouraging primarily because now liberalization has, to a certain extent, assumed global proportions, and the industrial giants, like the US, Germany and Japan (because of historical as well as presently changed objective global political and security perceptions) seem to have their own different priorities. Understandbly, India does not figure high in their development strategy calculus.

Nonetheless, India now looks towards the FRG and US for cooperation with greater expectation for their increased input in its development because it has opened up its market to the interplay of the global factors of free enterprise in a big way, thereby setting its economy on a new wave-length not in disharmony with their economy paradigm. Furthermore, these two Western industrial powers along with Japan constitute the global triad of economic and technological order. They have, over the years, been the largest exporting nations. FRG and Japan have also been enjoying largest surpluses in their world trade. Even though now unified Germany is preoccupied with economic reconstruction of its eastern part and is also deeply committed to making economic reforms a success in Central-Eastern Europe, yet , hopefully it would not leave out a big market like that of India (its traditional stronghold) to be taken care either by Japan or other major European powers. As such, India's trade with Germany has not been affected in any way. Rather during the past two years, Germany's investments, joint ventures, and technology transfer have been showing improvement.

In regard to the US, despite significant diverging political and security perceptions of the two countries, it figures high in India's frame of economic development. The reasons are understandable. With the disintegration of the USSR, US has emerged not only as the only supreme power at the apex of the unipolar system, bearing prime position in the economic, scientific and technological domains, but also seems to have assumed responsibility for making free enterprise a success, if not in all, atleast in as many world regions as possible. As such India has as much reason in deepening interaction in the economic and technological arenas with the US, as the latter ought to have in responding positively to it. However in the last few years, discernible difficulties have been experienced at the bilateral level owing to the US insistence on India signing the Nuclear Non-Proliferation Treaty and also the Missile Technology Control Regime (MTCR) convention. So far, India has not acquiesced to the US demand. As a result India had to be content with a lower grade 14 X-CRAY supercomputer for its Light Combat Aircraft (LCA), and now under the US pressure, Russia has refused to supply cryogenic rocket engines and related technology to India. Yet, it has to be acknowledged that the two nations are playing their diplomatic cards skilfully primarily because both sides are convinced that democratic symbiosis in their context has to be kept up.

Chapter I examines India's perspectives on cooperation for development with the FRG and US. India charted out its own path of development. It opted for the ''mixed-economy'', assigning commanding heights to the public sector, which somehow did not help realise the desired levels of its economic and social development. Apropos, it also deals with trade, aid, and investments from the FRG and US to India from the Indian perspective.

Chapter II analyzes the US policy on Technology Transfer to the Third World, with particular focus on India. US has never been keen on transfer of its technology to the Third World, even though outwardly its policies had been designed to demonstrate in interest its helping the latter in its quest for economic and social development. Further, high technology transfers are a complex phenomenon, they are of dual-use, both in the civilian and military domains, and the US is wary of creating a technological monster, which could be a threat to global peace and development. Still further, the US insists on adhesion to its patent laws, intellectual property rights, and makes use of its export control laws in furtherance of its foreign policy goals.

Chapter III examines Germany's perspectives on transfer of technology to India. Germany, having resurrected itself from the debris of the Second World War, knows it well how horrrendous is the task of a nation's economic and social reconstruction and development. Germany did it on an exemplary speed within a decade after the Second World War, and this came to be known as an "Economic Miracle", which somehow was not viewed approvingly by its architect, Professor Ludwig Erhard, Minister of Economy under Dr. Konrad Adenauer's regime in the 1950s. Germany was among the first majors power to have contributed to India's development of basic industries. It established Rourkela Steel Plant in the late1950s. Germany's track record by way of its trade, aid, investments and joint ventures has been impressive. But then this has not been commensurate with the potentialities of the two countries. India's trade with Germany is no more than 0.6% of the latter's global commercial transactions.

Chapter IV is the first case study on Computers. Both computers and telecommunications form an intrinsic part of the information technology, and their competent use indicates a measure of progress. It is seen that India is using computers in various arenas of industrial activity. It has created a tangible market for software exports, yet its share in the global market is less than impressive.

Chapter V is another case study dealing with telecommunications. Possibly, one could have studied it by enquiring into the functioning of the C-Dot system. But I chose to examine India's background with a view to understanding its capability for absorption of this new high technology, and then emphasized the need-based appropriateness of digital switching system in this country and also try to find out what India may need in the coming years.

Chapter VI and VII form basic firm studies of Siemens and WIPRO respectively. They indicate the usefulness of transferring high technology to India, and also indicate that there is substantial scope for India to acquire more of high technology, particularly now when India has embarked upon liberalization of its economy and its openness to foreign MNCs, both in the domestic and foreign markets.

Finally Chapter VIII bears over-all conclusions of this study. One thing that emerges clearly is that India's economic and social development depends upon its modernization through its procurement of high technology from the US and Germany, two industrial giants in the global economic and technology triad. Another point is that India's diplomacy needs to be geared up to respond to the new challenges which have emerged as a result of the openness of the new markets of the former Soviet bloc, which for historical and security reasons attach greater importance in the development strategy calculus of the US and Germany. Else, there lurks the danger of India continuning to be left on the periphery of the new centres of world development as they (in the post-cold war era) seem to be shaping up.

Acknowledgements

I would first of all thank Professor H.S. Chopra without whose initial encouragement I would never have begun this task and without whose goodwill and continued guidance I would never have completed it either.

I would also like to thank profoundly the legion of librarians and the library support that I received from Mrs. Uma Chopra, Ms Amita and their entire staff at the Institute for Defence Studies and Analyses, and Mr. Chander Prakash at the Department of Science and Technology, who went out of his way to help soliciting conference proceeding from senior officers. At the USICA, Ms Heera Kapasi and her wonderful team helped me efficiently each of whom I am immensely grateful to. The library staff at the Indian Council of World Affairs was most cooperative.

After initial hesitation, officers at the Electronics Export Council, Aeronautical Defence Agency, Technology Development Centre, Manufacturing Association for Information Technologies, were forthcoming with interviews and information.

At Wipro and Siemens, too, I got a plethora of data and information and I would like to thank all those who helped me, specially Mr. Chaturvedi of Siemens, and the Anal Jain of Wipro.

A lot of research help was given to me at the EEC library, IIC library and the ICRIER. I need to specially thank the library staff at the Columbia University library and Dr. Robert Shuey at the Congressional Research Services, Washington, D.C., Mr. Bruce Cromack at the Department of Commerce and those who gave me time in the U.S. Department of Defence and the State Department.

The Friedrich Ebert Stiftung staff at New Delhi and Bonn have encouraged my work and thanks in this goes especially to Dr. Thomas Meyer and his wonderful wife Helga, Dr. Heinz Bongartz, and Dr. Else Fricke.

Air Commodore Jasjit Singh literally helped me get started. Col. R.P. Singh encouraged and even got me excited about the concept of "dual use" technologies.

Col. R. Rama Rao took time and patience to peruse and comment on my work and was very encouraging.

Dr. Kota Harinarayana gave me valuable suggestions.

Dr. Valluri was most helpful in giving me important information and encouraging me in my work.

Dr. K. Ramchand provided encouragement, and supported my study.

There are very many loyal friends without whom I would never have wanted o get on with my thesis.

Many thanks to hours of support to a young friend and ex-student, Sonali Verma. More comments and suggestions came from Dr. Hartirath Singh and Mr. Subroto Banerji.

Many thanks to the painstaking typing and help given by Rajiv Sawhney, Deepak awhney and Suresh Rajput.

Last and most important are my twin children Rohan and Reethira without whose active cooperation, patience and tolerance I would not have been wanting nor able to finish my work.

Veena RaviKumar

August, 1993

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Abbreviations

AI	Artificial Intelligence
AID	Assistance for International Development
ASR	Air Staff Requirements
BEL	Bharat Electronics Limited
BHEL	Bharat Heavy Electronic Limited
BRITE	Basic Research in Industrial Technologies in Europe
CAD	Computer Aidied Design
CAE	Computer Aided Engineering
CED	Computer Electronic Dresden
COCOM	Coordinating Committee on Multilateral Controls
DARPA	Defence Advance Research Project Agency
DFI	Direct Foreign Investment
DGTD	Directorate General of Technical Development
DOD	Department of Defence
DOE	Department of Electronics

DM	Deutsch Mark
DOT	Department of Telecommunications
DRDO	Defence Research Development Organizations
ECIL	Electronics Corporation of India Limited
EDP	Electronic Data Processing
EEC	European Economic Committee
ESPRIT	European Strategic Programme in Information Technology
EP	European Parliament
ESS	Electronics Switching Systems
FAO	Food Aid Organization
FDDI	Fibre Distributed Data Interface
FERA	Foreign Exchange Regulation Act
FMS	Flexible Manufacturing Systems
FRG	Federal Republic of Germany
GIS	Geographical Information Systems
GNP	Gross National Product
GSM	Groups Special Mombile

HAL	Hindustan Aeronautics Limited
HCL	Hindustan Computer Limited
IIASA	International Institute of Applied Systems Analysis
IITL	India's Informations Technology Limited
IPR	Intellectual Property Rights
ISDN	Integrated Services Digital Network
ITI	Indian Telephone Industry
LAN	Local Area Networking
LCA	Light Combat Aircraft
LIS	Land Information Systems
LRDE	Laboratory Research Development Establishment
Mil Specs	Military Specifications
MOU	Memorandum of Understanding
MNCs	Multinational Corporations
MNEs	Multinational Enterprises
MRTP	Monopolies Restriction Trade Practices
MTNL	Mahanagar Telephone Nigam Limited

NASP	National Aerospace Plane
NATO	North Atlantic Treaty Organizations
NICNET	National Information Council Network
NRDC	National Research Development Corporation
NSF	National Science Foundation
NTPC	National Thermal Power Corporation
ODA	Official Development Assistance
OECD	Organization for Economic Cooperation and Development
PACT	Programme for Advancement of Commercial Technology
PACER	Programme for Acceleration of Commercial Energy Research
PCs	Personal Computers
PDP	Project Development Face
R & D	Research and Development
RACE	Research in Advance Commercial Technology in Europe
RBI	Reserve Bank of India
SDI	Strategic Defence initiative
SPR	Science Policy Resolution

STP	Software Technology Park
SCL	Semiconductor Complex Limited
TAAS	Technology Absorption and Adaptations Scheme
TCS	Tata Consultancy Services
TEC	Technology Evaluation Committee
TPS	Technology Policy Statement
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
VLSI	Very Large Scale integration
WAN	Wide Area Networking
WIPO	World Intellectual Property Organizations

Chapter I

India's Perspectives on Development Cooperation with FRG and USA

Development Objectives

After India's independence in 1947, the Government of India evolved a foreign policy based on the principles of non-alignment and self-reliance. Its basic premise was the rejection of the isolationist or autarkist concept of national development and the strategy of dependent development.[1] Harmony between interdependence and self-reliance was the special feature of India's foreign policy. The strategy to achieve self-reliance was the diversification of India's sources of foreign aid, foreign trade, and private foreign investment.[2] This meant maintenance of India's independence in global affairs and the elimination of asymmetric linkages.

This ensured for India freedom of action in world affairs and provided it opportunities to establish linkages with a large number of countries irrespective of their power-bloc affiliations.[3] Relations with the USA and FRG, among others, developed and strengthened within this framework of India's foreign policy.

British policies distorted and obstructed India's economic development. The struggle for India's independence against colonial rule was also directed towards liberating the Indian market from the control of the colonial exploiters.[4] The struggle

1. CP Bhambhri, The Foreign Policy of India, (New Delhi: Sterling, 1987), p.110.
2. KB Lall, Struggle for Change: International Economic Relations, (New Delhi: Allied Publishers, 1983), p. xxx ix
3. Op. cit.
4. Bipan Chandra, Rise and Growth of Economic Nationalism in India, (New Delhi: PPH, 1969) p.3

for freedom created a consciousness among Indians that economic development could take place only within a free country, and that alien domination led to under-development and economic distortions.[5] Therefore, after attaining freedom from the British, the Government of India evolved a strategy of development which would ensure that no foreign power would be able to control the economy and thus dominate the country. An aspect of the West which appealed to India immensely was science and technology. Jawaharlal Nehru admired the industrialization of the West and thought of science and technology as an instrument for Indian industrialization.[6] India needed foreign aid, technology, and private foreign capital for development,but it evolved a policy of regulating the free flow of private foreign capital to safeguard indigenous economic development.[7]

In the circumstances India's foreign economic policy was based on the diversification of sources of foreign aid, regulation of private foreign investment in the core sectors of the economy, and emphasis on technological collaboration with the developed industrial countries.[8]

As a British colony, India had been reduced to a supplier of raw materials to feed the manufacturing activities of the metropolitan centres of the British Empire and a market for their manufactured goods.[9] As a consequence, India was ruined economically. The major movements of industrial investment in India during this period (upto 1914) were thus determined by its place in the economic system of

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5. Ibid., n.1, p.110
6. Jawaharlal Nehru, An Autobiography, (London: John Lane, the Bodley Head, 1936) p.449
7. Ibid.
8. Ibid., n.2
9. Inid., n.4, p.5

the British Empire.[10] The dependence of India as a colony on Britain was total. It was this experience that determined the choice of free India's development strategy. The dilemma was whether to integrate totally with the capitalist world order, or structurally delink itself to maintain a certain level of independence. It was sought to be resolved through the formulation of a policy of mixed economy and non-alignment in foreign affairs, to ensure a desired level of self-reliance and an independent national economy.

Unfortunately, the economies of the Third World are even today characterized by an unbalanced, structurally defective, incoherent economic cycle. This is the result of their historically rooted integration into a system of unequal international division of labour. This has inevitably reduced them to the state of only reacting to the direction of the development of a world economic system decisively determined by the capitalist industrial nations, more so in contemporary international politics.[11]

One view deems it correct to term these industrial nations as the metropolis and the Third World societies as peripheries: it makes sense, further, to describe to dependence of the metropolis for specific goods and services in the peripheries and their integration into the world market, as structural dependence; for the latter case, the reproduction dynamics of the metropolis are transferred into the structure of the peripheries themselves (with considerable deforming repercussions) whereas no comparable process takes place in the opposite direction.[12]

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10. Amiya Kumar Bagchi, Private Investment in India: 1900-1939, (Delhi: Orient Longman, 1975) p.76
11. Dieter Senghas, Journal of Peace Research, (Oslo) vol. 12, no 4, p. 250
12 Ibid.

The issue here being how to abolish the 'dependency' status of India, the strategy used was the adoption of a system of "planned economy"[13] and a powerful state sector capable of pushing forward the development process and accelerating the pace of change. The two aims guiding India's planned development since the independence, were to build, by democratic means, a rapidly expanding and technologically progressive economy and social order, based on justice and offering equal opportunity to every citizen, and to change a traditional society into a dynamic one through peaceful democratic means with the consent of the people. The growth of the industry was to be speeded up and economic progress accelerated through planned development.[14] Lack of capital equipment and financial resources being important obstacles in India's, economic development necessitated bilateral international cooperation.

The Government of India has encouraged foreign collaborations by providing for repatriation of profits and an assured and stable relationship with foreign investors in joint ventures.[15] Its policy has been to encourage forty (in certain cases up to fiftyone) per cent equity participation of foreign investors in such ventures. An exception is made if the product is export-oriented or if the collaborator is bringing sophisticated technology.[16] Foreign capital and investments in India are protected by legal and institutional arrangements of the government such as the Foreign Exchange Regulation Act of 1973.[17] To sum up, the Government of India

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13. Government of India, Planning Commission. The Third Five Year Plan, (New Delhi, 1975)p.4
14. Ibid., p.7
15. Ibid., n.1, p.111
16. Ibid.
17. World Development Report, 1989, (Wash. D.C., 1989) p. 107

has so far regulated foreign investment, but the flow not having been as expected, the policies have been revised in the Industrial Policy Statement which links industrialization to development and growth.[18]

In this framework, the Indian perspective has with regard to the policies and programmes of cooperation with both FRG and the USA been set up to accelerate development. The Indian need for technology is increasing with the growing modernization of the economy and the transfer of high technology has become one of the elements crucial to development cooperation with both the FRG and the USA.

Development Cooperation:- Development cooperation raised the issue of evolving a new framework of cooperation which would respect the sovereign rights and responsibilities of developing countries for relating policy and structural changes to their social and economic circumstances, while helping them to expand their capabilities through a more coordinated mobilization of external capital, technical and administrative expertise and technology, which they require to fulfil this task.[19] An initial focus of development cooperation was on the ''gap'' in living standards and average incomes of developed and developing countries. ''Catching up'' policies called for accelerated investment, primarily in social overheads, physical infrastructure and industrial sectors. The focus on closing the ''gap'' with developed countries proved unfortunate through the so-called development decades.[20] The setting for development cooperation activities and the perpetual debate on future

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18. Ibid., n. 2. p.xxxii

19. A Time for Concerted Action in International Development Cooperation, 1977 Review, Development Cooperation. Efforts and Policies of the Members of the Development Assistance Committee OECD. (Paris) pp 22-25.

20. Pradip K Ghosh, Development Cooperation and Third World Development (Connecticut: Greenwood, 1984) p.112

prospects in this area are continuously changing in line with national and international developments in the political and economic spheres. The problem lies in striking an appropriate balance between continuity and flexibility.[21] Development cooperation embraces key developmental problems and projects and includes technical cooperation in a major way.

The dramatic changes of 1989 which took place in Central and Eastern Europe, and the integration of the European Community are factors which will influence the course of events in the world. This will also offer new opportunities in development cooperation.[22] While programmes of financial and technical assistance are the central elements of development cooperation with developing countries, there are many other forms of cooperation including the whole range of promotional and advisory activities in such areas encouraging foreign direct investment, access to capital markets, trade promotion and industrial, technological, scientific and educational cooperation.[23] India's aid receipts have remained limited in relation to GNP, but are quite substantial in relation to total foreign exchange available; some 15 per cent of total imports have been financed by net foreign aid over recent years.[24]

Unfortunately, India does not fall within the range of nations which have achieved strong economic growth as an aid-user. Its modest growth nevertheless is marked by real progress. India, Kenya and Malawi were still among the low-income coun-

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21. Deutschen Gesselschaft für Technische Zusammenarbeit (OTZ) Annual Report 1989 (Eschborn, 1990), p.12

22. Ibid, p.13

23. OECD, Twenty five years of Development Cooperation: A Review, 1985 Report, (Paris, 1985).

24. Ibid., p.279

tries in 1985.[25] This is not at all to suggest that foreign aid has been the decisive factor in the developmental progress of the fast growers or that development cooperation or aid is indispensable for successful development. Aid is only a supportive and catalytic element in the complex of factors for development. Yet, tying of aid, widely practiced by rich countries while providing assistance to Third World nations, is a form of protectionism, according to the Organisation for Economic Cooperation and Development (OECD).[26]

Tying aid to specific commodities and services or to procurement in a specific country or region could increase development project costs by as much as 20 to 30 per cent.[27] In fact, untied bilateral or multilateral development aid might, in the long term, benefit the donor's own export interests, for indirectly, such aid might stimulate the recipient's economic growth and consequently, that country's imports, as well as encourage policies of a more externally-oriented nature.[28] The share of untied aid in total bilateral ODA remains relatively small, and for most countries practically negligible, despite pleas to shift from tied aid to practically untied aid.[29]

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25. Ibid.
26. "The Tying of Aid". Monograph. OECD Paris. 1991 (Consulted in FICCI).
27. Ibid.
28. Times of India. 18 April 1991
29. Ibid.

INDIVIDUAL DAC MEMBER'S AID:

from Germany to India[30]

		Percentage of total ODA [31]	
1970-71	1980-81	1985-86	1989-90
10.7	4.1	4.6	3.6
from total ODA $m			
766	4226	3999	7038

from US to India[32]

		Percentage of total ODA[33]	
1970-71	1980-81	1985-86	1989-90
13.9	3.3	1.5	1.2
from total ODA $m			
3328	6973	10147	10409

Analysing the data, it was found that the percentage of ODA from US to India in 1988-89 was as much as to Costa Rica, Jamaica and Guatemala.

Since the focus is on technological cooperation, it is interesting to note the Technical Cooperation Expenditure (net disbursement in $ million) :

30. OECD Development Cooperation, 1987 Report. (Paris. 1988). p.233
31. OECD Development Cooperation, 1991 Report. (Paris. 1991) p.220
32. Op. cit. p.228
33. Op. cit. p.225

	1980	1986	1990.[34]
from Germany	1234	1510	1498
US	1063	1675	2607
Out of total DAC	7385	9157	11,150

India had the highest amount of aid in 1970-71 as part of total DAC [35]

	1970-71	1980-81	1989-90
	11.5	3.9	2.4
from total ODA $ m			
	7884	28720	55952

The point well brought out for all to observe is that technological cooperation is possible well within the framework of development cooperation policies. But there is a lacuna in the policy of the rational disbursement of aid whether tied or untied.

The aim of the thesis is to project India's role as well as absorptive and acquisitive capacity in high technology with respect to its transfer from USA and FRG. For this reason, the implications of science and technology policies, the definitional elements of technology transfer, and the parameters of the same will have to be dealt with. Moreover, a theoretical framework of analysis of the political economy approach, too, needs to be spelt out.

34. OECD Development Cooperation, 1991 Report, OECD (Paris, 1991.) p.207

35. Ibid., p.226

Science and Technology Policies of India and its Implications

The failure to appreciate the social and political role of science and technology, has also resulted in delinking science and technology from economic, social, cultural and political objectives, which has been catastrophic.[36] The effective linkage of science and technology with economic development and political objectives has brought about social and cultural transformation, such as in Europe and Japan.[37]

The delinking in developing countries has led to their dependence in terms of science and technology, as well as economic development. Substantive development cooperation and transfer of technology was one way out of this slow growth situation. India's first Prime Minister, Jawaharlal Nehru was perhaps the only political leader amongst those of the Asian and African countries, who understood this linkage and emphasized the role of science and technology in national development.[38]

While science is codified knowledge, technology represents the capacity that man has acquired to use materials and to enrich himself with artefacts.[39] Economics, then, represents man's capacity to use the resources generated by science and technology to create wealth and the system of its distribution.[40] Therefore, the Scientific Policy Resolution (SPR) of 1958[41] and the Technology Policy Statements

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36. Abdur Rahman. Intellectual Colonisation (Delhi: Vikas 1983) P.5

37. Ibid.

38. SRValluri. "A View from India"; in Science Polices, eds., P.J. Lavakare. J. George Waardenburg (London: Pinter. 1989) P.21

39. Op Cit., P.13

40. Ibid., P.14 Fs. n.2 P.xxxix

41. G. Muneesh Kumar. International Transfer of Technology to India (New Delhi. Annual Publications. 1988) p.13

(explicitly framed only in 1983) were expected, at their respective stages, to become the guide post for the planning process through the five year plans. The planning process was expected to convert these various policies into programmes that could be implemented through the five year plans.[42] Expectations have exceeded achievements and resources, but the belief in science and technology, as the essential ingredient for rapid improvement in living standards has been reinforced. Science and technology has been utilised as an instrument for the transformation of even the industrial base. The Government of India, therefore, set up a large public sector for heavy industry and encouraged the establishment of a private sector to respond to consumer needs.[43]

It had been expected that the industries established then would start interacting with the R & D and the academic system and finally create a self-generating technology base.[44] The departments of Space and Atomic Energy are examples of this self-generating technology base in the development of launch vehicles, satellites and nuclear power plants.[45]

A draft paper for a new Technology Policy has been introduced in 1993 by the Department of Science and Technology.[46] This is mainly to strengthen the Indian economy and assist the nation in fulfilling its role in the global economic environment with confidence and a sense of urgency. Its main elements are to ensure greater accessibility of technological devices to all segments of society,

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42. Ibid.
43. Ibid.
44. Ibid.
45. Ibid., p.25
46. Dept of Science & Technology A Draft paper for A New Technology Policy, (New Delhi, 1993.)

enhance infrastructural facilities, upgrade traditional skills, and reduce drudgery, keeping in view the special needs of women and weaker sections of society; and to encourage industries for enhancing human skills to upgrade industry technologies to comparable international levels as well as to attain such levels, for newer and emerging technologies.[47]

Apart from emphasizing issues of technology and environment, the thrust areas for technology development were critical technologies, regardless of whether they were currently available from abroad; and secondly, those aimed at new products and services and technological refinements over currently available technologies.[48] The importance of this policy paper is that it emphasizes research, development and engineering as well as points to linkages between industry and academia. In essence, it broadens the base for technology development. Also, it aims at technological refinements over currently available ones. Yet, because of priorities for the Indian State in terms of planning, i.e., food production, power generation, health and sanitation, even the Seventh Five Year Plan, with the issuance of the Technology Policy Statement (TPS), seems to indicate that planning for science and technology stands somewhat in isolation from the rest of the planning process.[49] The TPS also set out the principles of acquisition of technology through import and foreign investment, high-tech priorities, and absorption.[50] Further, from time to time, several policy statements have been issued which have a direct bearing on the R & D in India, in particular the Industry Policy of 1956, the

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47. Ibid., p.1
48. Ibid., p.3
49. Ibid.
50. SKShrivastava,. and KV Swaminathan, "National policies towards the R & D system in India", in n. 38 p. 53

SPR of 1958, and the TPS of 1983.[51]

In India, the Ministry of Science and Technology has evolved several schemes in the area of technology. Mention has been made of promotional measures to facilitate the establishment of in-house R & D centres.[52] A new scheme called Technology Absorption and Adaptation (TAAS) has been evolved to absorb imported technology. A scheme on the national register of foreign collaboration has also been initiated which provides information on past records of joint ventures and the means for making reports on technologies in several industries, with a view to assisting in further acquisition of technology.[53] A scheme on transfer and trading in technology has been evolved with a view to increasing technical cooperation with many developed countries (i.e., FRG, USA) and in this, efforts are being made to assemble technology profiles of different countries and to facilitate the mutual exchange of experience and technology. There is also a scheme to support consultancy services as an important part of technology transfer.[54] Yet, there is comparatively little evaluation and assessment.

In spite of these schemes, Indian expenditure on R & D is minimal. Although India now spends about one percent of its GNP (against two to three per cent in developed nations) on R & D, only five to six per cent of this amount (as against 20-30 per cent in advanced nations) is available to higher educational institutes.[55] In absolute terms, the R & D budget in Indian Universities amounts to about Rs. 1

51. Ibid., p.51
52. Ibid., p.55
53. Ibid., p.55
54. Ibid.
55. Ibid., p.47

billion per year as against about Rs 200 billion per year spent in the universities in the US[56] and even this is restricted to only a few.

One of the important factors in the development of a country is the number of persons in the R & D profession. It is estimated that in the US, there are 67 R & D professionals for every 10,000 persons; Japan-63; FRG-50; UK-32 and in India there are fewer than three R & D professionals per 10,000 persons. There are numerous gaps in R & D– infrastructural and others—which need to be rapidly remedied to prevent a technological "brain drain"; also, there must be more cooperation and collaboration between universities and research laboratories, and industry, along with the introduction of an R & D culture at nascence.[57] This would be more consistent within the technological framework for peace and stability. It would form the basis for international cooperation. The recent draft of the Indian Government goes on to stress further the importance of R&D through concrete measures. The aim is to double the number of personnel involved in R & D from the present 3.01 lakh by the year 2000.[58]

The 1993 policy underlines the role of industry. It aims at persuading the industrial sector to contribute two to three per cent of its annual turnover, amounting to Rs 2000 to Rs 3000 crores, exclusively for developing technologies. The annual turnover of industry, excluding the small-scale sector which will be exempted from the cess, is estimated to be around Rs 100,000 crores.[59]

Another important aspect of the policy is to double the national R & D expen-

56. Ibid.

57. Ibid.

58. Times of India, New Delhi, 22 February 1993

59. Ibid.

diture as a percentage of the gross national product (GNP) through enhanced contributions from industry by the year 2000. It also seeks to set a target of national R & D expenditure to be at least two per cent of the GNP as against the present figure of 0.89 per cent.[60] The national R & D expenditure had remained below one per cent of the GNP since independence. The highest percentage was 0.98 achieved in 1987-88.[61] Now, 76.8 per cent of the national R & D expenditure (approximately Rs 3542 crores) is contributed by the government and the remaining 23.2 per cent (Rs 1058 crores) by the industry (10.6% by the public sector and 12.6% by the private sector).

The Minister of State for Science and Technology, Mr P R Kumaramangalam, said that the draft policy emphasizing the development of critical technologies and the accent on R & D, implied that the four decade old emphasis on indigenous development of imported technologies will end. There would be no barriers against import of proven technologies. "There is no need to waste time reinventing the wheel," said Mr P R Kumaramangalam.[62]

The 1983 technology policy, too, had suggested a cess from industry, as mentioned earlier, but it could not be implemented due to strong opposition the industry. Now, Mr Kumaramangalam admitted that it would be difficult to push through this plan during the 1993-94 recession period. Industry, however, should consider the fact that technological obsolescence plays a major role in reducing the market share and, thereby, profits.[63]

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60. Ibid.

61. Ibid.

62. Ibid

63. Ministry of Industry, Government of India, Industrial Policy, (New Delhi): 24 July 1991 p.16

Science and technology policies affect technological development by stimulating R & D, setting up a scientific infrastructure, and giving preference to the output of indigenous technology and, indirectly, by regulating access to foreign technologies.

The Indian Government has, since Independence, set up a massive infrastructure to provide commercially viable techologies to manufacturing, mining, agriculture and defence. As far as manufacturing goes, the bulk of the effort is concentrated in the 33 national laboratories of the Council of Scientific and Industrial Research, which also covers such fields as experimental medicine, aeronautics, environment, oceanography and structural engineering.[64] Its commercial arm, the National Research Development Corporation (NRDC) has not had much impact on technological development in large-scale organized industry, though it claims to have provided hundreds of technologies for use to small-scale enterprises. No assessment is really available of the cost and efficiency of these technologies.

Where incentives to in-house R & D are concerned, the Indian Government, through the Department of Science and Technology in collaboration with the Directorate General of Technical Development (DGTD), operates a scheme whereby 'recognised' R & D units of industrial enterprises receive fiscal concessions and other incentives which have been quite successful.[65]

The Indian Government adopted a progressively more restrictive policy towards the import of foreign technologies from the mid-1960s, mainly in response

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64. Sanjaya Lall, "India's Technological Capacity" in Fransman and King eds., Technological Capability in the Third World, (London: Macmillan, 1984) p.233

65. Department of Science and Technology Report, (New Delhi, 1991) p. 6.

to foreign exchange shortages. Controls were applied at several stages on access to foreign technology in the form of licensing agreements as well as direct foreign investments. The very first stage was to demarcate industries into three categories: those in which the government believed indigenous technology to be sufficient for the country's needs, and no foreign investment or licensing was to be allowed; those where some foreign technology was thought necessary but was not of a complex or tightly held nature, so only licensing would be allowed; and those where both licensing and direct investment would be allowed.[66] The list of industries was first issued in 1969 and updated in 1978.

After growing stringency, there had been some liberalization and, now, even more so. Nevertheless,a rather facile and static view of technological needs, coupled with a formidable bureaucratic and taxation apparatus, has served to keep new technologies out of a large number of activities.

As with many regulatory polices, a large area of discrimination was left to the administrators, resulting in arbitrariness, delay, political interference and, ultimately, corruption. Recently, of course, procedures for screening have been streamlined, but India, by all accounts, still remains a relatively difficult country to enter.

If a foreign technology qualifies to enter India, by way either of licensing or direct investment, there are still a number of regulatory hurdles and restrictions to be cleared. Up to 1977, all proposals for technology imports in any form had to run the gamut of every ministry concerned with industry, finance, technology and the CSIR before getting approval. Objections could be raised (and lengthy delays

66. Op. cit., p.235

instituted by recalcitrant bureaucrats) at practically any stage of the process. These objections could be based on the cost of the technology, its appropriateness, the availability of local substitutes, or even the long-term building up of indigenous R & D capabilities.'[67]

Since 1976, a Technology Evaluation Committee (TEC) has been set up. It is composed of members of the DGTD (under the Ministry of Industry), Department of Science and Technology (DST), CSIR and NRDC.[68] The TEC evaluates the technological aspects of every proposal for collaboration and the extension of existing collaboration agreements. It then advises the ministry or department concerned on the technical desirability of the import and the ministry proceeds with further action. If the Department itself is inclined to take a very narrow view of technology imports, it can impose a far more restrictive policy than recommended by TEC. The prime example is the electronics industry, where an extremely nationalistic Department of Electronics has been able to so restrict technology inflows as to set Indian electronics firms back by over a decade in a very fast moving field of technology. This was amply demonstrated by microelectronics in the Bharat Electronics Limited, Bangalore, which could have leaped ten years if R & D had been invested in it. According to Dr A Prabhakar, Manager, Microelectronics, BEL, India could easily become one of the Asian giants if transfer of technology of electronics packages (e.g., VLSI technology or microchips) could be effected.[69] The motivation was present and the cost benefit analysis would point to greater

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67. Sunil Mani, Foreign Technology in Public Enterprises, (New Delhi, 1992), p.10
68. Ibid., p.3
69. Interview with Dr A Prabhakar, BEL Microelectronics, (Bangalore) 29 June 1991

efficiency and less cost in the long run. Moreover, the Electronics Department has persisted in this, in spite of strong criticisms from high powered committees (e.g., The Sondhi Committee) set up to recommend means of improving electronics technology in India. Thus, even within sectors, where foreign technologies are permitted, there has been a strong filtering mechanism which has a built-in bias towards protecting indigenous technologies and producers.

The onus lay on the prospective importer of technology to show that it was necessary (in terms of plan priorities), not available locally, and 'fairly' priced. The system probably deterred a large number of firms from seeking approval for technologies may have improved their function but which were unlikely to pass through the filter. This brings us to one to the complexities of definitions of technology, its transfer mechanisms, parameters and controls.

Definition of Technology

While the word "technology" has been defined as "the application of science to the (industrial) arts", [70] today, concern and interest in the development, use, and diffusion of technology, along with technology transfer, are points of debate beyond the circle of research scientists, engineers, entrepreneur and scholars as well as economists and political scientists. Technology is now linked with the international order and economic growth. It also deals with the functioning of state intervention, government, its definition and restrictions.[71]

International transfer of technology takes place when knowledge in one coun-

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70. Brittannica World Language Dictionary, (New York, 1959) vol.2, p.1288

71. Otto Hieronymi, ed., Technology and International Relations, (London: Macmillan, 1987) p. 69.

try-which may have been developed there or acquired from somewhere else—is communicated to people in another country for use there.[72] Transfer implies a process linking the technology supplier to the technology user. Technology transferred depends on the type of technology and industry, governmental regulatory restraints, the size of the market, the sophistication of the user, and the costs and benefits to the supplier and the user.[73] The sophistication of the user of the technology and the strength of the management know-how, are particularly critical in the transfer of managerial technology.

Two important principles have emerged: first, that the technology of the developed nations is not automatically ideal or even always suitable for the developing nations and, second, that the developing nations need not necessarily pass through the same succession of stages that the vanguard of developed nations has undergone.[74]

The four major actors in the technology transfer process are 1) the technology supplier, 2) the environment of the supplier, 3) the technology recipient or user and 4) the environment of the recipient or user.[75] There is a source supplying the technology and a user receiving it. Both are conditioned by their respective economies and governmental regulations. Through the process of transfer, the technology supplier becomes the transferring agent.[76]

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72. Frances Stewart, "International Technology Transfer: Issues and Policy Options", in Paul Streeten and R Jolly, (eds.) Recent Issues in World Development (New York: Pergammon, 1984) p.67.

73. Fund for multinational management education, vol. 1, p.4

74. The New Encyclopedia Brittanica (Chicago, 1985) p. 482.

75. Harvey W Wallender III, Technology Transfer and Management in the Developing Countries. (Massachusetts: Ballinger, 1979), p.12

76. Ibid., p.13

Theories of Technology Transfer: There are many such theories, depending on the economy of the state and political governance. Some of the major ones focussing on the supplier of technology are:

1) Multinational corporations or MNCs as oligopoly/monopoly owners of technology
2) Dependency theory
3) Screening approaches
4) Supplier consideration approaches[77]

MNCs as oligopolies consider it necessary protect their proprietary knowledge, patents and highly developed managerial and marketing skills.[78] They want to control their own technology, have proprietary protectionism, and make profits on the same.[79] Now, with changing global paradigms, MNCs have evolved alternative strategies and perpectives on technology transfer.

Dependency theories were first articulated in the late 1950s through development of the centre-periphery model which divided the world into industrialized centres, holding majority of productive capabilities, and periphery areas, supplying the centre with raw materials[80] Where the result was dependence on foreign sources of supply through the international transfer of technology, development of a local technostructure became inhibited.

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77. Ibid., p.19
78. Stephen Hymer and Robert Rowthorn. "Multinational Corporations and International Oligopoly: The Non-American challenge" in Charles Kindleberger, ed., The International Corporation (Cambridge: MIT Press, 1970), p. 91.
79. Svennilson, Ingvar. "Technical assistance: the Transfer of Industrial Know-how to Non-Industrial countrees," in Berill K. ed. Economic Development with Special Reference to East Asia, (New York: St. Martins 1964). p. 206
80. Raul. Prebisch. "Commercial Policies in the Underdeveloped Countries", American Economic Review, (Washington, D. C.), Vol. 49, no. 2, May 1959 p. 25-73

Another variation of this theory derives from an historical analysis of the growth of MNCs and introduces the new international division of labour.[81] Under this division, a North Atlantic regime of MNC firms seeks to structure the international economy along hierarchical lines, similar to the internal hierarchical structure of the firms themselves. The result is the geographic naturalization of control over the international economy, creating patterns of inequality and dependency. There is a tendency, then, to rely on foreign technology inappropriate to development planning. The cost of this technology is assumed to be too high, resulting from a price set by the monopolistic MNC firms.[82]

Screening approaches presuppose the formulation and articulation of national policies on technological and developmental criteria for deciding what types of technology and under what conditions technology may be imported.[83] They also call for the creation of national agencies to screen technology projects. Supporters of screening approaches generally favour MNC presence through joint ventures and licensing agreements instead of wholly owned subsidiary arrangements.[84] Screening tests the receiving environment and local capability to use imported technology.

Supplier Consideration Approaches focus again on the supplier and underline

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81. Andrew Sayer, Kevin and Morgan, "High Technology Industry and the International Division of Labour: The case of Electronics" in J. Breheny Michael Ed by and W Robert Mc. Quaid. The Development of High Technology Industries (New York: Croom Helm, 1987) p.10

82. E M Graham, "The Terms of Transfer of Technology to the Developed nations: A Survey of the Major Issues" in North south Technology Transfer the Adjustment Ahead (Paris: OECD, 1982) p.61

83. n.75, p.22

84. E Ingerson, and W Bragg, eds., Science, Government and Industry for Development (Austin: University of Texas, 1975) pp 203-44

the transfer cost.[85] The cost of international technology transfers is inversely related to the number of years of manufacturing experience in the user organization and the age of the technology.[86] Therefore, because of the high costs incurred, suppliers prefer to transfer technology to experienced recipients. Here, there is too much emphasis on the supplier of technology and not enough on the characteristics of the user firm and the technological infrastructure that affect receipt and use of technology.

The Role of Theory in Transfer of Technology

The above theories are more conducive in a conventional paradigm of transfer of technologies. Framing it in the perspective of international relations, global factors overtake the direction of policies and, within this, emerge conceptual and spatial factors. Emphasis on certain theories negates other theories. The focus on MNCs as suppliers tends to disregard consultancy firms, university laboratories or public training institutions, equipment salesman, foreign government programmes and private volunteer organizations. Similarly, global factors, too, cannot be narrowed down but point to a greater globalized network, an international division of labour (especially in the electronics sector) which, in turn, points to interdependence, a technology parity sharing. Also, the transfer of high technology particularly forms a genre of its own. High technology transfer seems to have a value addition in terms of political and economic value. Further, there is the issue of high technology for both civil and military purposes, as also of export controls regarding the same.

85. David Teece. The Multinational Corporation and the Resource Cost of International Technology Transfer (Massachusetts: Ballinger, 1976) p.100

86. Ibid.

The picture of the international political economy that emerges is one in which power is central and deemed to be empirically ubiquitous.[87] The global political economy thus envisaged is a political economy in two central respects. First, power is manifest in most of its central features and the exercise of that power is beset by all the indeterminacies of general power policies—unpredictable calculations of potential advantage, uncertain choices, efforts at image-manipulation and the posing of threats.[88]

The second intrinsically political feature of the contemporary international political economy derives from the extensive opportunities that exist for linkages, and transfers of capabilities between issues and contexts. Outcomes in one area can be linked to, or made conditional upon, outcomes elsewhere; a decision on military procurements from a particular country, for instance, being made conditional upon some new trade concession from that country. The possibilities of such linkages are endless in a world of such complexity as today's and render international relationships intrinsically as a matter of political economy. Transfer of technology comes within the second perspective.[89] This approach does not deny market processes, rather, it locates them within a broader structural analysis which identifies their role and significance more effectively.

From the perspective of political economy, technology is now the most important factor of production; and the capacity to produce it equals power. It follows that the development of exploitation of technology tends to change power relation-

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87. Barry Jones, ed., Perspectives on Political Economy: Alternatives to the Economy and Depression., (London: Frances Pinter 1983) p.203

88. Ibid.

89. Ibid., p. 204

ships, whether these are social, economic, political, or military.[90]

The potential of technology has repeatedly, in recent decades, led governments to collaborate in the elaboration and implementation of new technological projects.[91] The above framework makes the two nations, FRG and USA, which are important technology-wise, the most likely nations for India to collaborate with.

Methods of Transfer of Technology

The methods of technology transfer are through conferences, published papers or private communications, training and educational programmes, consultants, patents, licences and through know-how agreements, turnkey jobs, and foreign investments.[92]

Mechanism of Transfer of Technology

The various mechanisms of technology transfer are: movement of people between different fields of science and technology, entrepreneurial activity, scientific and technological literature, interaction of the developer with the user, training and education, consultancy and advisory functions, marketing application engineering, accidental personal contacts, foreign collaboration, indigenous R & D working in close cooperation with entrepreneurs and UN bodies and aid programmes.[93]

There are basically two types of transfer of technology, viz., vertical and

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90. Roger Williams, "The International Political Economy of Technology", in Susan Strange, ed., Paths to International Economy, (London: Allen and Unwin, 1984) p.70

91. Geoffrey Price, "Political Frameworks for the control of Technology: An assessment" in Johnston and Gummett, eds., Directing Technology, (London: Croom Helm, 1979) p. 247

92. M. Srinivasan, Management of Science and Technology, (New Delhi: East-West press, 1939) p.153

93. Ibid., p.153-154

horizontal. Vertical transfer may be through invention, prototype and engineering to an operational system. Horizontal transfer takes place when experts move from one science or industry to another.

Channels of Technology Transfer

Technology is the knowledge that leads to improved machinery, products and processes. Additions to this knowledge reduce the real cost of production and lead to the introduction of new products.[94] Integration with the global trading system, the path India is treading now, affects technological change in two ways. First, it improves the supply of new technology. Second, it raises the demand for new technology. Technology is embodied in imported inputs and capital goods, sold directly through licensing agreements and transmitted through direct foreign investment, labour movements, or contacts with foreign buyers. In all these ways, openness increases the supply of new products and processes.[95]

Indian Perspectives on Technology Transfer

One of the objectives of planned economic development of India has been growth with self-reliance, especially in industrial technological capability. This has been in the area of capital goods and certain intermediate goods sectors. Technology for this is complex and the market calls for tough negotiations. Nevertheless, the government, being an active participant in technology transfers, is believed to be able to obtain technology in these critical areas on favorable terms and conditions and also absorb it to generate indigenous capabilities.

In India, the goal of self-reliance in technology was sought to be achieved

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94. World Development Report 1991 (Washington, D.C., 1991) p.88

95. Ibid., p.89

through subscribing to a strategy of "import and adapt". This strategy was effectively controlled by a tight regulatory policy with respect to the mode and conditions under which technology transfer could take place. A strategy of self-reliance that also involves major efforts at transferring, adapting and improving existing technologies, can provide a greater degree of technological maturity. To ascertain how far this set of policies has affected the development of indigenous technological capabilities is complex and cover a wide field. Available evidence presents a mixed picture: certain areas of Indian industry are technologically backward and increasingly so, especially in such fast changing areas as electronics. On the other hand, there are a number of Indian firms assimilating imported technologies and even effecting improvements on them.[96]

A brief survey of the policies of the Indian Government with respect to foreign collaboration will supplement the reasons. It reveals three distinct phases. The first phase covers the first two decades of Independence till 1968, when foreign collaboration with equity participation was encouraged. This was considered to be the best mode of technology transfer, to secure high technology which otherwise would have been difficult to obtain.[97]

A number of tax concessions were extended by the government to streamline industrial licensing procedures to avoid delays in approval of foreign collaboration. The Indian Investment Centre was established in 1961 to forge a close link between foreign and Indian firms. This led to a spate of collaborations which may have led to the import of non-essential and often inappropriate technology: inap-

96. Sunil Mani, Foreign Technology in Public Enterprises, (New Delhi: Oxford & IBH, 1992) p.1
97. Ibid., p.2

propriate for the factor endowments of the country.[98] Apart from acquiring technology through financial participation, turnkey contracts with foreign firms as the prime contractor was another source. During 1957 to 1967, about 254 such agreements were entered into for plant construction, and a large proportion of them were in the public sector.[99]

Against the background of a growing criticism of such large-scale reliance on foreign sources of technology, the government appointed the Mudaliar Committee in 1966 to examine the conditions subject to which indigenous know-how can be deemed to be capable of commercial exploitation and to suggest general guidelines regarding the types of cases in which foreign collaboration may be allowed.

The report was submitted in 1967, recommending a stricter approach to the extension of existing collaboration agreements; favouring outright purchase of technology through drawings and designs, rather than equity participation; where technological obsolescence is rapid, and avoidance of repititive import of the same technology. It suggested liberal treatment with regard to the provision for foreign exchange for import of essential instruments and equipment for research laboratories.[100] Following this report, the Foreign Investment Board was constituted in December 1968, to approve foreign collaboration cases, except those where the total investment exceeded Rs 2 crores of equity capital and where the foreign investments exceeded 40 per cent of the issued capital.

The main accent of the second phase of government policy covering

98. Michael Kidron, Foreign Investments in India (London: Oxford 1988), p.101.

99. Sunil Mani, ibid., n. 96, p.2.

100. Mohammed Saqib, Foreign Direct Investment in India: Trends and Prospects Mimeo. ICRIER, 1991.) p. 68

to the early 1980s, was the strong discouragement technology acquisition via the mode of Direct Foreign Investment (DFI). In 1967, India's stock of DFI was in the range of $ 1.5 billion as compared to $ 1.3 billion in Brazil, $ 78 million in Korea and $ 1.8 billion in Mexico.[101] This shows the relative importance of this mode of technology acquisition (which was to be regulated).

The government issued in January 1969 an illustrative list of industries where: a) foreign investment might be permitted; b) only foreign technical collaboration might be permitted but not foreign investment; and c) no foreign collaboration (financial or technical) was considered necessary.[102]

Moreover, in order to bring down the price of technology, the government imposed a pre-tax ceiling of three per cent or royalty for most products and five per cent for some with more complex technologies. Only in exceptional cases, where technology was difficult to obtain or if substantial exports were expected, higher rates were allowed. In addition to these ceilings, actual royalty payments have been subject to a 40 per cent withholding tax, so that the collaborator could receive a maximum of three per cent royalty. The other important component of the explicit price of technology, viz, lump sum payments, were subject to a withholding tax of 20 per cent.[103]

Technology acquisition through licensing agreements was subject to a maximum period of validity, which was reckoned to be five years, as opposed to

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101. C Dahlman, and F Sercovitch, Local Development and Exports of Technology: The Comparative Advantage of Argentina, Brazil, India, The Republic of Korea, and Mexico. World Bank Staff Working paper No. 667, Table 5, 1984.

102. Ibid., n.96 p.3

103. Ibid.

about 15 years (or so) in the agreement contracted in the pre-1968 phase. Careful screening of licensing agreements was introduced through the Technology Evaluation Committee of the DGTD. As mentioned earlier, FERA was passed in 1973 diluting foreign ownership by 40 per cent of the total equity (except for wholly export-oriented enterprises or for those using "sophisticated technology").

Finally, even embodied technology imports, in the form of import of capital goods, were regulated through high tariff barriers and quota restrictions. It is felt that this strict regulatory policy adopted towards technology import was to a great extent, inspired by the Japanese experience.

After disillusionment with strict policies, especially in the excessive bureaucratization resulting in delays on collaboration approvals, the government, in the third phase, from 1985 to now, has been prompted to dismantle some of the controls-and relax others. This was also considered as an imperative because of the restrictions on royalty rates and other payment-related aspects of the contracts, particularly in a market of a limited economic size.

This implications of these changes are that until recently, Indian firms have been offered packages that are less than complete. Even when state of the art designs were included, the packages offered were frequently the bare minimum necessary to enter into new lines of production employing only "average practice" technologies.[104] This was especially so in industries which were undergoing rapid changes. As part of the liberalization package, the government announced a technology policy statement in 1983, already discussed earlier in this chapter as also

104. Ibid.

goes the R & D policy. It was followed by the 1992 Draft Policy Statement. Enough data is not available to map out the relative importance of the mechanisms of technology transfer, but available data indicate that the acquisition of technology via the medium of licensing or technical collaboration agreements are by far the most important, accounting for about 80 per cent of the collaborations approved between 1948 and 1988.[105] (Table 1).

An interesting inference which can be drawn from Table 1 is that cases involving financial participation, which averaged around 34 per cent in the period 1960 to 1968, came down to nearly half during 1969-1978, clearly reflecting a tighter policy with respect to such cases. They are once again on the rise and form, on an average, 19 per cent of the cases approved during the post-1978 period, reflecting the liberalized policy.

In technology transfer literature, it has been hypothesized that the cost is likely to be higher when technology is imported through DFI due to transfer pricing and other imperfections.[106] There can be a positive correlation between the cost of technology import and the policy with respect to it.

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105. Foreign collaborations-1988. National Register of Foreign Collaborations. Department of Science and Industrial Research. Delhi. p. 1

106. Frances Stewart. "International Technology Transfer Issues and Policy options" in Paul Streeten and R Jolly. eds., Recent Issues in World Development. A collection of Survey Articles. (New York: Pergamon. 1984) pp. 67-110

Table 1: Foreign Collaboration Approvals: 1948 to 1988

Total	Total number of cases approved	Cases involving foreign capital participation	percentage share of 3 in 2
1	2	3	4
1948-55	284	-	-
1956	82	-	-
1957	81	-	-
1958	103	-	-
1959	150	-	-
1960	380	-	-
1961	403	165	40.95
1962	298	124	41.61
1963	298	115	38.59
1964	403	123	30.52
1965	241	71	29.46
1966	202	49	24.26
1967	182	62	34.07
1968	131	30	22.90
1969	134	29	21.64
1970	183	32	17.49
1971	245	46	18.78
1972	257	36	14.01
1973	265	34	12.83
1974	359	55	15.32
1975	271	40	14.76
1976	277	39	14.08
1977	267	27	10.11
1978	307	44	14.33
1979	267	32	11.99
1980	526	65	12.35
1981	389	56	14.40
1982	588	113	19.22
1983	673	129	19.17
1984	740	148	20.00
1985	1041	256	24.59
1986	960	256	26.66
1987	903	259	28.68
1988	957	289	30.20
Total	12847	2724	21.20

Source: Foreign Collaboration -1988 (A compilation: National Register of Foreign Collaboration, Department of Scientific and Industrial Research, Delhi, p.1)

It is possible to conclude that regulation reduces cost. If one accepts this, one can see Indian firms, too, assimilating technology and adopting them to local conditions, ergo, towards technological self-reliance.[107] The working definition of this term would be that if an enterprise, over a period of time, reduces its expenditure on imported technologies reduced relative to that on in-house R & D, its track record in the direction of self reliance along a technology ''dependence- independence continuum'' would be good. The R & D factor for development, in general, has been already established. Further, R & D among Indian manufacturing firms is low. Organized in-house R & D is, indeed, concentrated in a few industrial groups, such as like electricals and electronics, chemicals, drugs and pharmaceuticals and engineering goods.[108]

Technological progress is not just a factor of development it is also a means to the elimination of poverty. An important aspect of the poverty problem is the frequent coexistence of dynamic and stagnant sectors side by side, as in India.[109] Such dualism persists in India. Therefore, development cooperation priorities have changed materially and qualitatively toward such countries, as India.While Official Development Assistance remains a critical need, expansion in exports and acquisition of high technology are preferred.[110] It is also a fact that the most important support needed from developed nations, such as FRG and USA to India is action to sustain and stabilize trade and financial flows and transfer of technology. Trade,

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107. Homi Katrak. ''Imported technology, enterprize size and R & D in a Newly Industrializing Country: The Indian Experience.'' Oxford Bulletin of Economics and Statistics 1985 vol.47, no. 3: pp 213-229

108. Ibid..

109. Pradip K Ghosh. Development Cooperation and Third World Development (Connecticut: Greenwood 1984) p.11

110. Ibid.

aid and investment are interconnected with technology transfer, as already observed.

Aid has been spelt out in terms of ODA from both USA and Germany. It seems to be on an increase in the case of the US, except in 1987. Where German bilateral aid is concerned, after a spurt in 1980, there have been ups and downs but a negligible increase so far,[111] as seen in Table 2. The politics of aid is an insidious one but, as it is not the major core of this thesis, it need not be dealt with here. Suffice it to say that development cooperation with USA and FRG engulfs trade, aid, investments and technology transfer. This will be discussed in reference to the respective countries concerned in subsequent chapters. Investment too has been profiled in the Indian perspective. It may often be accompanied by useful technological, industrial, managerial, and marketing support.

Table 2

Western Countries: Official Economic Aid Commitments to Less Developed Countries, by Donor[a]

(Millon US$)

	1980	1983	1984	1985	1986	1987
New Zealand	78	51	53	63	74	74
Bilateral	54	40	41	47	34	51
Multilateral	25	11	11	16	40	23
Norway	449	532	638	622	868	880
Bilateral	247	288	350	346	548	514
Multilateral	202	245	288	275	321	366
Bilateral & Multilateral figures	858	734	792	826	1,092	1,380
Switzerland	188	398	261	381	442	572

111. Directorate of Intelligence, Handbook of Economic Statistics, 1990. (Washington, D.C., 1990.) p.187

United States	6,464	9,464	10,477	10,280	10,753	9,365
Bilateral	139	239	218	307	329	462
Multilateral	49	158	42	74	113	110
United Kingdom	2.449	1.647	1.679	1.397	1.944	2.613
Bilateral	5.378	6.989	8.144	9.157	8.746	7.412
Multilateral	1.086	2.475	2.333	1.122	2.007	1.953
West Germany	6.278	3.234	3.834	3.552	4.767	5.697
Bilateral	4.667	2.271	2.800	2.427	3.337	4.303
Multilateral	1.611	963	1.034	1.125	1.430	1.394

a: Data is for calendar years.

Joint ventures are receiving increasing attention in the collaborative efforts of developing countries to promote industrialization. These are a comparatively flexible instrument in that they can assume many different modalities concerning initiative for establishment, ownership of sources of management and technology and market arrangements for the provision of inputs or sale of their products. The initiative can come from the government or from private corporations.[112]

Market arrangements take different forms. Within this, it is common to establish joint ventures that benefit from trade liberalization under existing integration schemes. This may bring about technological change.[113] India, too, has participated in high technology joint ventures, as brought out in the case studies on computers and telecommunications. Therefore, India, too, has liberalized its trade regime.

The development strategy of the 1970s sought to engage countries in a wide range of issues and sectors, and set specific targets in order to encourage and measure progress. An important new feature was a better synthesis of social and

112. Ibid., n. 118

113. Ashok V Desai. Market Structures and Technology. The Interdependence in Industry. (New Delhi: ICRIER. April 1984) p.1

economic goals: "The ultimate objective of development must be to bring about a substantial improvement in the well-being of the individual and bestow benefits on all." If extreme poverty and social injustices persist, then development fails in the essential purpose."[114] The emphasis was on greater equity and social progress.The Third World is no longer seen as marginal to the effective operation of the global economy, but fits into a specific area of the international division of labour.

Recent events in international trade and finance have demonstrated interest in common among developed and developing countries. The objectives of sustained and stable economic growth, freer trade, stable commodity markets, security of food and energy, transfer of technology, are all in the longer term interests of all nations. A reaffirmation of objectives for a better sharing of the economic benefits of growth among nations can be affected by a stepped up transfer of resources and removals of constraints which impede the realization of a more fair and open trading system.

Therefore, trade gets linked as an important aspect of development strategy and as a pointer to the transfer of technology.

World output and trade expanded during the 1980s as a whole, at a much slower pace than in the preceding decade. IMF estimates show that during the 1980s, real output in the world economy expanded at an annual rate of 2.9 per cent against 3.9 per cent during the 1970s. For industrial countries, the growth rate was 2.7 during the 1980s, against 3.3 per cent during the 1970s and for developing countries, the growth rates were 3.2 per cent and 5.6 per cent, respectively.[115]

114. United Nations General Assembly Resolution 26 26(xxx), 24th October 1970.

115. Ministry of Finance, Government of India, Economic Survey 1990-91 (New Delhi, 1991) p. 174

The growth in the volume of world trade decelerated from 6.2 per cent per annum to 4.7 per cent during the 1980s. For industrial countries, volume growth of exports decelerated from 6.6 per cent to 4.7 per cent and for developing countries from 4.1 per cent to 3.1 per cent per annum during the same period.[116] Likewise, there was deceleration in the growth of import volume in both groups of countries. This is mainly due to protectionism, with bilateral export restraints, which marked the international trading environment during the decade, playing an increasingly important role. According to the UNCTAD, the number of export restraints grew from about 50 in 1978 to 263 in 1989. These protective polices were introduced mainly by developed countries and applied mainly against developing countries.[117]

Of course, the EEC as a single market (1992), will have both trade-creating and trade-reducing effects, with its complex system of preferences. India's share in EEC import is as small as 0.3 per cent. In this case, India will have to be more competitive in price, quality, design, marketing, packing, adherence to deli ery schedules, etc. Further, economic reforms in Central and Eastern Europe may change the profile of world trade and aid.

116. Ibid.

117. Ibid., p. 175

The following Table 3 will indicate India's exports, imports and trade balance from 1980-90.[118]

TABLE-3

7.1 INDIA'S EXPORTS, IMPORTS AND TRADE BALANCE

Rs. Crores

Year	Exports (incl.Re-exports)	Growth Rate	Imports	Growth Rate	Trade Balance
1980-81	6711	4.6	12549	37.3	-5838
1981-82	7806	16.3	13608	8.4	-5802
1982-83	8803	12.8	14293	5.0	-5490
1983-84	9771	11.0	15831	10.8	-6060
1984-85	11744	20.2	17134	8.2	-5390
1985-86	10895	-7.2	19658	14.7	-8763
1986-87	12452	14.3	20096	2.2	-7644
1987-88	15674	25.9	22244	10.7	-6570
1988-89	20232	29.1	28235	26.9	-8003
1989-90	27681	36.8	35416	25.4	-7735
1990-91 (P)	32527	17.5	43171	21.9	-10644

(P) Provisional

Unfortunately, there was a slowdown in exports in 1990-91. It was one of the poorest results recorded in the last decade.[119] With exports of $ 18.128 billion, the growth was around nine per cent over 1989-90, compared to the average 17 per cent growth in exports in dollar terms maintained over the previous four years.[120] Imports, too, had increased amounting to Rs. 43,171 crores. In dollar terms, imports in 1990-91 grew by 13.1 per cent compared to the previous four-year

118. Ibid., p.-77

119. Economic Survey 1992-93 (New Delhi. 1992) p.99

120. Times of India, 12 August. 1991

average of eight per cent per annum, with the result that India's trade deficit in 1990-91 grew by 27.8 per cent in dollar terms, to a record $ 5, 932 million or Rs 10,644 crores.[121] The Reserve Bank of India did step in to announce liberalization of the export refinance formula making sure that banks would finance exports to the extent of 60 per cent of the increase in export credit, as against fifty per cent so far.[122]

An extensive view of aid as a component of development policy, along with the question of Trade Balance is crucial to the Indian perspective on technology transfer. With the main objectives of aid and development policy being mutuality of interests, military and political considerations, social justice and human development, official development assistance from OECD countries is an inevitable fact. Such assistance has remained a fairly stable percentage of their GNPover the last two decades.[123] It was only 0.33 per cent in 1970 and 0.35 per cent in 1990 but two facts must be highlighted: That during these 20 years, the GNP of the OECD countries registered a very substantial growth in real terms so their assistance also registered a substantial quantitative expansion; secondly, except for UK and USA (where there was a sharp decline between 1970 and 1990), others increased their assistance, e.g., Germany providing $ 6.32 million ODA in 1990) from 0.33 per cent to 0.42 per cent of 6 NP and Japan from 0.23 per cent to 0.31 per cent.[124] So, aid disbursement has not lagged behind, even though it is not 0.7 per cent of GNP, as specified in the United Nations resolution.

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121. Ibid.

122. Times of India, 4, Sept 1991.

123. Arjun Sengupta, "Aid and Development Policy in the 1990s", Economic and Political Weekly, vol. no.28, 11, 13, March 1993 p. 454

124. Ibid., p. 455

Bilateral sources have been important to India. Five countries—USSR, UK, FRG, France and Japan—have accounted for over 68 per cent of the total bilateral aid utilized by India over the years 1985-90. During the past five years taken together, Japan has led the group in bilateral assistance, accounting for 22.5 per cent of all aid utilized by India, followed by the FRG (3.8 per cent) France and USSR (11.2 per cent each and the UK (19.6 per cent).[125] Multilateral aid to India is mainly given by the World Bank. Of course, there are many conditionalities which go with this which have to be sorted out.

High Technology: Ramifications for India

Any classification delineating areas of technology into advanced and non-advanced could be challenged as being purely arbitrary. However, to put high technology into a cognisant framework would mean including those technologies most recently developed, not yet widespread, but with far reaching economic and/or national security implications, as well as technology which calls for a high level of scientific and industrial competence.[126] These may include nuclear technology, electronics, aerospace technology, ocean sciences and life sciences. Only a few developing countries may be interested in acquiring some of these technologies, whether from the US or the FRG. In any case, most of the technologies have security implications.[127]

From the Indian perspective, however, the areas in to which it would seek technological assistance are those mainly weapons, communications, energy and

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125. n. 124 p. 165

126. R Rama Rao. "Transfer of European Advanced Technology to the Third World" in K.B. Lall and H.S. Chopra, eds., The EEC and the Third World. (New Delhi: Radiant 1981) p. 52

127. Ibid.

related technologies, electronics, transportation, general engineering, machine tools, metallurgy, chemicals, engineering, nuclear and biotechnology.

In the broader sense, high technology cannot be separated from political dimensions, market structures, forms of competition, social setting, and above all, the quality of the education system and the working population.[128] Indian perspectives would have to take into consideration all there for technology absorption.

On the global scene, on the one hand, oligopolistic market structures are developing and on the other a process of decentralization is taking place. New and innovative enterprises are moving into and establishing niche positions. Global competition is more than just rivalry between firms. It involves competition between entire economies and for locational advantages for production systems, economic constitutions and social organization: in other words ''structural competition''.[129] In this context, Japan and the Pacific region appear as an economic and technological threat not only to the Europeans, but also to the US, leading to an intangible US perception of declining political power.[130]

In this expanded networking of political power, microelectronics is the basis of the information age and assumes a key role in the computer and telecommunications industry and in other branches of the economy with a substantial electronics content. Hence, its relevance in this thesis, too. In the Indian perspective, too, microelectronics, along with computers and telecommunications, forms an important aspect of industry which can absorb high technology.[131] High technology trans-

128. Klaus W. Grewlich ''The Technology Race.'' Aussen Politik. (Hamburg, 1991) vol. 42, no.4, p. 383

129. Ibid., p. 384

130. Ibid., p. 385

131. Interview with Dr Ashok Desai, formerly in NCAER, 29. April 1991..

fer thus assumes a connotation that mere technology transfer does not. The slow diffusion of technologies is widely considered to lead to increasing economic and consequently, political dependence.[132] Inversely, greater spread of technology is bound to lead to interdependence. The previous day's high-tech is the next day's commodity item.[133] One major facet of high-tech items is that they cannot usually be bought off the shelf and their transfer to developing countries requires special permits and special controls. This is more so in items that are used for both military and civilian purposes. In other cases, companies are concerned about their loss of adequate compensation for potential technology.[134]

The logic of business has not only internationalized technology, but the spillover has begun to occur from civilian to military applications particularly in computer, semi-conductor and communications technologies.[135] In each of the highly specialized industrial technologies that have been developed incrementally by the societies leading in that specialization, the technology followers had the natural advantage of leapfrogging to bypass the intermediate stages of development, learning through the experience of the technology leader. The late entrants also differed in their approaches which revealed the advantages of one over the other. While countries, such as Japan, Taiwan and South Korea chose the value-added approach of improving, manufacturing and managing export-led marketing of information technologies. India, by contrast, approached its high-tech industrial development in terms of total self-reliance and technical mastery over the entire prod-

132. Ernst Dieter "Technology and Global Economic Security" in Manas Chatterji, ed., Technology Transfer in the Developing countries (Houndmills: Macmillan, 1990) p. 294

133. Toufiq Siddiqui, n.7, p. 154

134. Ibid.

135. R P Singh, "Trans Century Technologies", Strategic Analysis (New Delhi) 6 Sept 1991 vol 14, no. 1 p.706

uct.[136]

The belief that a large quantity of high technology R & D has dual use applications, irrespective of whether these are engineering goods, chemicals, electrical or electronic industries, has led to the development of such theories as those of spin-off advantages and military as a moderniser. Unfortunately, these have not been proved so either in the Middle East or South Asia, the two regions which have been the largest recipients of high-technology military equipment for the last 40 years.[137] On the contrary, the reverse is indicated by the Japanese and South Korean commercial technologies which have given them a competitive potential for sustaining the growth in military technologies.

The reasons for the lack of military-to-civilian technology spin-offs is perhaps due to the classified nature of the research environment of military R & D; the narrow scope and smaller scale of military applications; and the different set of criteria attending military research in terms of operational utility; performance quality, reliability, costs, versatility and durability. Notwithstanding these limitations, dual utility application could be developed from a range of generic technologies, e.g., commonality of electronic components for surveillance by CBI and discriminate weaponry with developments in information and sensors for commercial applications.[138] It is at this crucial juncture of high-technology transfer that the entire gamut of controls becomes important in the Indian context, especially vis-a-vis USA.

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136. Ibid.

137. Times of India, 5 April, 1991

138. Op. cit., p. 719

Conclusions

International transfer of aid, trade, investment and technology on the right terms, supporting broad-based development, is indispensable if the poorer nations are to achieve accelerated development and there is to be a chance of eradicating absolute human poverty. High-technology transfers have a genre of their own. They are linked directly to the science and technology policy of India as well as to the R & D within government and private organizations. Transfers take place at the government-to-government level with USA and FRG. Because these are international transfers, foreign policy making is important. The politics and the economics of the three nations play an important role in this. Again, the very nature of high technology transfers makes it imperative for other nations to exert 'controls' in their national interest rightly or wrongly. Transfers take place through firms, collaborations and joint ventures. The Indian perspective on high technology has been highly honed since pre-independence but new policies substantiate its motivations.

After the achievement of independence, India's emphasis was on development and alleviation of poverty. Both were seen as part of an integrated process. It was in this context that Prime Minister Jawaharlal Nehru had architected the science and technology policy. Positive efforts were made to acquire technology. In the post-Second World War era, first the USA and later the FRG emerged as the most developed nations in the West, in terms of science and technology. Over a period of time, they also topped the list of those providing aid to and in trading with India. They were also seen making investments in this country. In such circumstances it seemed to make a great deal of sense to establish the best possible relations with these two countries.

This, however, was not easy. India, the USA and the FRG were all free democracies. Nevertheless, the perspectives of India and these two countries did not always match. The fault lay with both sides. The Indian administrative culture was very bureaucratic. This constituted an obstacle to the development of healthy foreign economic relations. It thwarted investment and technology transfer from both the USA and the FRG. As already pointed out, official development assistance for India was about the same as provided to such small countries as Costa Rica, Jamaica and Guatemala. Obviously there was much scope for an improvement in US efforts to provide development assistance to India. Aid from FRG in 1989-90 was just 3.6 per cent of the total ODA. It was a very meagre amount.

There has been a considerable amount of transfer of technology from the USA and FRG to India. Unfortunately, their objectives and motivations did not always meet India's requirements. This is particularly true of the USA. Its primary concern has always been what it perceived as its national security interests, which had global dimensions. Till recently, its national security perceptions had been coloured by the Cold War. This proclivity still continues. The best example is the attitude towards the transfer of high technology, much of which comes within the grey area of both military and civilian use. The US has been rather wary of transferring such technology to Third World countries. Both the departments of Commerce and Defence control US export policies. There are laws within the Coordinating Committee of Multilateral Trade (COCOM) which strictly control exports. There is the additional factor of US Federal Laboratories transferring technology to industries, which gives them a say in the further transfer of such technologies. All these restrictions make transfer of high-technology from the US to India rather problematic.

This is true of the FRG too. Its industrial policy makes it difficult for it to transfer high technology to India. Understandably, profit is its primary motivation, however much it might be placed within a rhetoric of peace and development. Hence, it is easier for it to deal with countries with a similar orientation and with less regulatory policies.

US economic policy in relation to India has further been coloured by its global strategic-military and political-in this region, in the context of the Cold War, in which India was perceived to be linked with the Soviet Union. The FRG too could not quite escape from the logic, as part of the NATO and the COCOM. This meant that it too could not pass on high technology to India regardless of its consequences.

In the circumstances it would probably be correct to say that whatever might be the declared motivations and policy perspectives, in relation to India's development problems, the strategic concerns-economic, political, and military in the case of the USA-have so far restricted the approach of both the countries towards economic and technological collaboration with India. The wide gap in perceptions and perspectives that exist need to be bridged. May be, the current policy changes in India and the urgent need for markets for the crisis-ridden economies of the advanced countries, would help to bridge this gap.

Chapter II

US Policy on Technology Transfer To Third World Particularly India

US Role in International Technology

America's role in international markets for high technology products has been dominated for quite some time by highly unrealistic expectations. These expectations were formed in the years immediately following World War II, when a whole generation of Americans grew up surrounded by tangible evidence of their country's across-the-board technological superiority. For 20 years or so, following the Second World War, and for reasons closely connected with the uneven incidence of that war and its aftermath, American technological leadership was one of the prime facts of international life. The years from 1945 to the mid or late-1960s were, without doubt, the age of American technological hegemony.[1]

Due primarily to the war-time devastation, the other member states of the Organisation for Economic Cooperation and Development (OECD) lagged far behind the US in technology. Soon, however, with US assistance to these nations through the Marshall Plan, they rapidly recovered from the wreckage of was with fast-paced technological upgradation.

However, as long as there was a substantial gap between the terms of technology of the United States and the other advanced industrial countries, possibility continued of rapid technological change through the transfer and adoption of the more sophisticated and productive American technology.

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1. Nathan Rosenberg, Inside the Black Box: Technology and Economics (Cambridge: Cambridge Univ. Press, 1982), p.280.

Thus, throughout the 1950s and 1960s and with varying degrees of effectiveness, the other OECD countries played a successful game of technological catch-up. A combination of high rates of capital formation, on the average far higher than in the United States, plus the importation and exploitation of more advanced American technologies, helped progressive to lower American technological, leadership in relation to Europe and Japan.[2] That was the scenario in the 1970s and 1980s.

Now, in the early 1990s America's earlier exclusive pre-eminence in numerous technological domains has been left behind. A good deal of convergence in the economic environment of a sizable number of countries is taking place. In contrast to American technological hegemony there have now emerged political entities such as Japan and Western Europe, which are equally technologically competent.

History of Technology Transfer

Transfer of technology is not just a recent phenomenon, but has existed throughout recorded history. Abundant archaeological evidence convincingly demonstrates that such transfers mere an important aspect of pre-historic societies as well. Francis Bacon observed, almost 400 years ago, that three great mechanical inventions--printing, gunpowder and the compass--had "changed the whole face and state of things throughout the world; the first in literature, the second in warfare, the third in navigation".[3] What Bacon did not observe was that none of these inventions, which so changed the course of human history, had originated in Europe, although it was from that continent that they first began to exercise their worldwide effects. Rather, each of these inventions represented successful instances

2. Andrew Pierre, J ed., A High Technology Gap? (New York: Council of Foreign Relations, 1987), p.5.
3. Francis, Bacon, The New Organon (Indiannapolis: Bobbs Merrill 1960), p.118.

of technological transfer, probably from China.[4]

But it was really British technology, in the last quarter of the eighteenth century after the Industrial Revolution, that provided the basis for industrial development first to Western Europe and later to the United States. New power sources, new modes of transportation and new techniques of metallurgy and machine-making, when organized and administered, brought immense improvement in productivity that transformed the lives of all participants.[5]

A number of highly renowned and fascinating persons participated in easing the process of transfer of technology to America. Latrobe helped establish the professions of architecture and engineering in America[6]; Eli Whitney, acknowledged as the "father of American technology", was a technological hero whose best invention was the cotton gin;[7] James Buchanan Eads, who as an engineer, devoted his services to the task of finding ways to organize and develop the potentialities of modern technology;[8] Thomas Edison of course flourished at the same time when the United States emerged as a great technological nation. This simultaneity was not altogether new, for Edison drew upon the sustaining environment and at the same time, helped create it.[9] Many others helped in technological innovations and transfers, e.g., Alexander Graham Bell, the foremost in communication.[10] Above all, it is a fact that in the US, transfer of technology took place

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4. N, Rosenberg, "The International Transfer of Industrial Technology: Past and Present", in North-South Technology Transfer (Paris: OECD, 1982), p.25.
5. Ibid.
6. W Carroll Pursell, Jr., ed., Technology in America, (Mass., MIT, 1981), p.35.
7. Ibid, p.45.
8. Ibid, p.80.
9. Ibid, p.47.
10. Ibid, p.105

in close association with the pattern of European migration and settlement, first to the US and then to other nations.[11]

Taxonomy of Technological Transfer

Technology, as a particular form of resource endowment, has been variously defined. Baranson, in a study on the transfer of industrial technology,[12] defines technology s "the knowledge set of processing and/or fabricating techniques required to produce industrial materials, components and end products". Typically it includes "data on equipment requirements, detailed processing sheets, standards and specifications for raw materials or industrial materials, quality control procedures and other related technical information."[13]

The simplest, yet all embracing definitions include those of Root, "the body of knowledge that is applicable to the production of goods and the creation of new goods" and of Jones, "The way in which resources are converted into commodities."

Teece[14] argues for a distinction between technology embodied in physical terms, e.g., capital goods, blueprints, technical specifications and that which takes the form of information which is necessary for the utilization of this hardware.

He identifies such unembodied knowledge as "methods of organization and operation, quality control, and various other manufacturing procedures".[15]

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11. Ibid., n.4, p.27.

12. J. Baranson, International Transfers of Industrial Technology by U.S. Firms and their Implications for US Economy (Washington D.c.: Developing World Industry and Technology, 1976), p.143

13. Ibid.

14. D.J. Teece, The Multinational Corporation and the Resource Cost of International Resource Transfer (Cambridge: Ballinger, 1977), p.91

15. Ibid, p.36.

The extent to which human as well as physical capital should be considered as a form of technology has never been completely resolved in the literature. The dividing line between the two is difficult to draw, if for no other reason than that today's physical capital embodies the innovatory skills and application of yesterday's human capital. A similar distinction was used by UNCTAD in guidelines for the study of the transfer of technology to developing countries. To quote:[16]

"Technology is an essential input to production, and as such it is bought and sold in the world market as a `commodity' embodied in one of the following forms:

i) in capital goods and sometimes intermediary goods which are bought and sold in markets, particularly in connection with investment decisions;

ii) in human labour, usually qualified and sometimes highly qualified and specialized manpower, with capacity to make correct use of the equipments and techniques and to master the problem solving and information producing apparati;

iii) in information, whether of a technical or of a commercial nature, which is provided in markets, or kept secret as part of monopolistic practices."

A final area of debate has been the distinction between technology and technological capacity, viz.,; technology as a flow of knowledge and technology as a stock of knowledge.[17] It is possible, so it is argued, that technology may be transferred from one country to another without there being a change in technological capacity of either country. This may be true if one thinks of technological capacity as the ability to generate new technology and of technology as an input for a particular type of production process. But the

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16. UNCTAD, TD/B/AC, 11/9 December 1972

17. Fransman and King, eds., Technological Capability in the Third World (London: Macmillan, 1984), p.9.

dividing line is rarely a hard and fast one, if for no other reason than that the learning process, associated with acquiring the new technology, may help advance the capacity of the recipient to create future technology[18] The Japanese case would be a classic example.[19]

Transfer of research and development (R&D) capabilities does tend to add to a country's stock of innovatory capacity, more than a transfer of production or marketing technology. To some countries, like India, the ability to generate new technology is one of the most important criteria by which imported technology is evaluated.

US Motivations for Technology Transfer

From the jungle of inter-related factors, all of which in some way or another, are likely to have some effect on the cost and benefits resulting from the export of technology, it is important to identify as to what goals developed countries have, which might be advanced or thwarted by transferring technologies to developing countries.

Unfortunately, different technology-producing nations have different goals, particularly, in the non-economic field. But all, to some degree or another, are interested in the impact of technology exports on a number of key strategic and economic variables. Those identified for the United States by Nau are the concern of most of the OECD member nations. Nau examined the impact of technology transfer from the US to four groups of countries (Soviet Union, advanced Western countries, resource-rich developing countries, and resource-poor developing countries) on five main policy objectives of the United States[20] These may be identified as motives for transfer. The five main motivations

18. Ibid.

19. Hearing Before the subcommittee on Technology and competitiveness. Acceleration of US Technology utilization and commercialization. 102nd Congress, first session (Washington D.C.) 7 May 1991. no. 28. pp 35-38.

20. HR Nau, et al, Technology Transfer and US Foreign Policy (New York: Praegar, 1976), p.4.

for U.S. technology transfer are: 1) military-strategic; 2) foreign policy-diplomatic; 3) economic-commercial; 4) social-environmental; and 5) administrative institutional.[21]

Clearly, these goals of the United States are not necessarily mutually consistent, in the sense that they are simultaneously obtainable; moreover, the value and priorities attached to them may vary over time.

Post-war developments in the US have changed the main emphasis of evaluating technology transfers from a largely military and strategic perspective, which prevailed from the end of World War II up to the early 1960s, to an economic and industrial one in the later 1960s. Although this emphasis continued in the 1970s, it began to be increasingly modified by an awareness of social-environmental implications, such as those illustrated in the late 1980s in the controversies over the export of fast breeder nuclear reactors and supersonic aircraft.[22]

Nau's thrust, as of some others, is that the main actors and initiators in technology production and transfer have shifted from non-commercial to commercial institutions, although indirectly as a result of a variety of government controls and policies, without specifically having anything to do to affect technology capacity and direction of technology creation and dissemination by private industry.[23]

Thus food and drug legislation has influenced the pattern of innovation in the pharmaceutical industry; government procurement policy has fashioned the direction of R & D in the computer and micro-electronic industry; and government space programmes have had a wide range of spin-off effects on several industries. The US Government,

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21. Ibid, p.6.
22. Ibid, p.7.
23. Ibid, p.14.

indirectly by its strategic economic and social policies continues to exercise considerable control over the direction of industry's technological capability and exports.

The economic and industrial consequences of technology creation and export are uppermost in framing US Government policy, although improving relative economic strength in the longer term might be as important a political goal.[24]

In spite of this, since the US economy clearly has a strong comparative advantage in technology, transfer of high technology is not a promising issue for it to cultivate in its relations with developing countries, such as India.[25]

Forms and Modalities of Transfer

The choice of method of transfer is dependent upon the type of technology and industry, governmental regulatory restraints, the size of the market, the sophistication of the user of the technology, and the costs and benefits to the supplier and user.

Technology transfer is generally a voluntary act by the technology owner and can take place through various mechanisms.

There are mainly two forms of transferers and transferees: commercial and non-commercial. The former largely comprise firms, although individuals might perform this role. Non-commercial institutions include the United States Government itself, international agencies (UNCTAD, World Bank) and non-profit making private institutions, e.g., charities.[26]

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24. R, Gilpin, War and Change in World Politics (New York: Cambridge, Univ. Press, 1983), p.182.

25. Hugh, Miller, Rolf, Pierkanz, eds., Technology, International Economics and Public Policy (Colorado: West View, 1982), p.19.

26. JH, Dunning, "Towards a Taxonomy of Technological Transfer and Possible Impacts on OECD countries, in OECD North/South Technology Transfer (Paris, 1982), p.13.

Secondly, there are three main forms of transferring technology from the US to India:

i) gifts;

ii) contracted technology; and

iii) non-contracted technology[27]

Gifts, e.g., may take the form of inter-government assistance or donations from private charities. Contractual arrangements range from turnkey projects, predominantly intended to export and start up a manufacturing operation (e.g., the Togliatti plant set up by Fiat in Russia)[28] through management contracts, franchising, leasing arrangements, co-production and complementation agreements to straightforward licensing. There is some evidence to suggest that the contractual form of resource transfer is increasing in importance, relative to that of direct equity investment.[29] Developing countries tend to prefer this form believing that it retains decision-taking within indigenous firms;in addition, most contracts are time limited and can be re-negotiated.[30] New varieties of contractual ventures, some involving consortia of both private and public institutions, are evolving all the time. Yet Streeten and Lall make the point that foreign direct investments benefit the technology transferor on.[31]

Terms of Transfer

Terms of transfer vary not only between different types of technology in the US but

27. Ibid.

28. Ibid, n.4, p.13.

29. JH, Dunning, 'Market power of the Firms and International Transfer of Technology', International Journal of Industrial Organisation (Amsterdam, 1983) p.337.

30. Ibid, n.20.

31. R.P., Streeten and S., Lall, "UNCTAD on Foreign Direct Investment in Developing Countries", TD/B/C3 (vi) Misc.6, 1973.

are also influenced by both country and organization/modality factors. The first item of the terms of transfer is the payment charged for the technology and the conditions attached to its provision.[32] The payment may vary from zero or near-free to a monopoly price, depending on the type of technology being marketed and the underlying supply and purchasing conditions. The price itself may take different forms, e.g., a contracted lump sum payment, a royalty based on the value of sales of the product in which the technology is embodied, an administrative and service fee, or a combination of the three.[33] In the case of technology supplied within a MNE, part of the reward may take the form of profits and dividends, or of gains resulting from intra-company transfer pricing.

The conditions attached to the supply of technology (which may be imposed by the supplying or purchasing firms or by governments, in this case US of supplying or purchasing countries) may range from none to a complex set of controls or restrictions on:

i) the use made of it;

ii) the markets to which the products it helps to produce may be sold; and

iii) the sourcing of inputs, both to produce the product in question and others manufactured by the transferee.[34]

Conditions may also embrace cross licensing agreements and other knowledge-sharing facilities. Both the price and the conditions of sale for any given quantum of knowledge may vary considerably with the organisation/modality of transfer.

32. Samuel Rosenblatt, Timothy Stanley "Technology Transfer in Practice: The Role of the MNC in Rosenblatt, ed., Technology and Economic Development: A Realistic Perspective (Colorado: Westview 1979), pp. 124-129.

33. Ibid.,

34. Interview with Mr. David Schlecty, Department of Commerce, Washington, D.C., 13 Oct, 1992.

Within the terms of transfer, the implication is clear that persons working in the receiving nations acquire knowledge from those in the donor nation (in this case USA) or that knowledgeable persons from the donor nations migrate to and work in the receiving nation, even if temporarily.[35]

Technology transfer can be achieved through numerous channels, apart from those mentioned earlier.[36]

1. One nation might send students or apprentices to other nations to acquire useful knowledge and skills;
2. citizens of a particular nation might learn from the technical literature published by other nations;
3. corporations based in one nation might create operating subsidiaries in other nations through foreign direct investment and transfer useful knowledge to them by various means, and
4. citizens of one nation might acquire technology through licensing contracts or outright purchase, in effect paying the proprietors of the technology to teach it to them.

To a great extent, the transfer of high technology from US to India takes place through two channels: foreign direct investment and inter-firm licensing.[37]

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35. Graham, E.M., "The Terms of Transfer of Technology to the Developing Nations: A Survey of the Major Issues" in n.20, p.55, Op cit.,

36. UNCTAD, "The Transfer of Technology", Journal of World Trade Law, London, Sept-Oct. 1970, pp. 708-9.

37. Interview with Mr. John E. Simmons, Office of South Asia, Department of Commerce, Washington D.C., 28 September 1992.

Is the cost of imported technology to India too high?

This question rests on what the benefits of the import are relative to its price. A lower price is justifiable when the opportunity cost of transfer of technology to India is substantially lower than the opportunity cost of utilizing it in either US or FRG.[38] In a private market system, a positive return from the creative effort depends upon the innovator's ability to charge a price more than the marginal resource cost of usage for the use of the technology. At first glance, this appears to justify a high price for technology transfer. At the same time it makes a good case for the less advanced nations to insist upon playing according to a different set of rules.[39]

In lowering prices for technology to developing nations, the marginal social opportunity cost to the industrialized nations is minimal. This is because the same degree of industrial nations irrespective of the revenues derived from technology sold to developing nations. Hence the inference that developing nations might be entitled to a "free rider" status, with the receipt of an asset (in this case, technology) at a price less than its full social cost.[40]

Compared to the total market, however, the market for industrial technology in developing nations is not particularly small. For the US., for example, receipts from developing nations accounted for more than 18 per cent of total fees and royalties in 1976. For the same year, this percentage was more than 19 per cent for Germany, almost 23 per cent for France, almost 28 per cent for the United Kingdom and more than 51 per cent for Japan.[41] It must be remembered that due to national differences in the definition of what

38. HG, Johnson, "The Efficiency and Welfare Implications of the Internation Corporation", in Charles Kindleberger, ed., The International Corporation (Cambridge: MIT press, 1970), p.37.

39. Gerald Meier Emerging from Poverty, (New York: OUP, 1984), p.161

40. Ibid, n.44, p.40.

41. CV, Vaitsos, "Foreign Investment and Productive Knowledge" in GF Erb, and V Kallab, eds., Beyond Dependency (New York: Overseas Development Council, 1975), p.52

constitutes fees and royalties, these figures are not strictly comparable. Figures include fees and royalties for the use of trademarks, which arguably are not payments for technology.[42]

Analysis have made numerous efforts to measure the cost of imported technology to developing nations. These efforts have almost universally been frustrated by problems of measurement. The only direct data available on payments for technology by developing nations are those for fees and royalties. As has been noted, fees and royalties, paid at arm's length transactions might not accurately reflect the true cost of the technology to the buyer, both because restrictive serve to raise the price of the transaction and because the figures reflect prices paid for trade marks as well as for technology. Several studies suggest that the use of restrictive covenants in contracts between seller in the industrialised nations and buyers in developing nations are very widespread.[43] For this reason, it is often claimed that published accounts of arm's length royalties and fees paid by developing nations are systematically biased, and do not help in understanding the true cost of the imported technology. In the case of royalties and fees paid by subsidiaries of multinational firms in developing nations. It is even less clear whether these figures represent anything close to the true cost of intra-firm technology transfer.[44] The supposition of most spokesmen of developing nation is that these figures also underrate the true cost.

It is less than startling that spokesman for multinational corporations do not accept these views. In a worldwide survey of corporate executives conducted in 1975, the Conference Board (a US based organization) uncovered a strong sentiment that prices

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42. Thomas C Creel, Drew M Wintringham "Patent systems and their role in the Technological Advance of Developing Nations" in Portfolio: International Economic Perspectives, vol. 12, no.1 (Washington D.C., USA, 1988) p. 256-257

43. Ibid.

44. Raymond Vernon, Storm Over the Multinationals (New York: Vail Ballore, 1977) p.10

charged for technology transfer tend to be "high in nominal terms" but not in excess of the opportunity costs to the corporation making the transfer.[45]

In calculating costs of imported technology to developing nations, the indirect costs cannot be ignored. According to the survey, prices are high because of rising costs to the corporation of maintaining research and development efforts, the costs associated with serving licenses, and "special risks" associated with the transfer of technology to developing nation.[46]

Indirect costs have to be taken into account in calculating the costs of imported technology to developing nations. Dimitri Germidis and Christine Brochet have summarized the results of nine studies of technology transfer contracts between industrialized and developing nations to analyse the impact of restrictive covenants on the effective price of technology transfer.[47] The vast majority of the 3,632 contracts they examined contained restrictive covenants of one sort or another and also the costs of these covenants to the purchasing nations were found to be indeterminable.

In the Indian case, taking the member of sample contracts as 1,051, there were 154 tie-in clauses (15%)and 455 export restrictions (48%) which really make for very restricted covenants on on technology transfer from industrialized nations to India. [46] The innovating rents are high initially for new technologies and contracts become complex.

Because the economic characteristics of both the supply of and the demand for a technology can change over time, the determinants of the price of technology

45. "White Paper on Technology Transfer and the Developing Countries", Chamber of Commerce of the United States, (Washington D.C.) Oct. 1976.

46. Ibid.

transferred internationally vary.[47] Technology transfer can just not be quantified.[48]

Therefore, one must conclude that the question of whether the costs of imported technology to developing nations are too high, is clouded by a lack of even an approximate estimate of their true magnitude. But whatever the actual price for technology transfer might be, spokesmen of developing nations by and large contend that a lower price is justified on grounds of fairness.[50]

Price of Technology: Dynamic Considerations

On the supply side, empirical work by Raymond Vernon and others on the "life cycle" of new product innovations bears note.[51] Early in the life cycle of a new product, the technology is likely to be closely held by the innovating firm. This firm is able to extract a monopolistic rent from its use or sale. Generally, if demand for a new product were to be price inelastic and the technology were to be unique and difficult to imitate, the rents would be high. Vernon argues that the initial demand for unique technologies will come from affluent buyers who are price insensitive and, therefore, it will indeed be price inelastic.[52]

The high rents extracted by an innovating firm, however, provide an incentive for new

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47. D., Germidis, ed., Transfer of Technology by multinational Corporations, vol.1, (Paris: OECD Development Centre, 1977), vol.1., p.62
48. KE, Boulding, "The Economics of Knowledge and the Knowledge of Economics", American Economics Review, (Nashville) 56, 1971, p.10.
49. Op. cit, p.63.
50. OECD North-South Technological Transfer (Paris, 1982), p.64.
51. Raymond, Vernon, Sovereignty at Bay (New York; Basic Books, 1971), ch.3, p.65-77.
52. G, Helliner "International Technology Issues: Southern Needs and Northern Responses", in J Bhagwati, ed., The New International Economic Order: The North South Debate (Cambridge, Mass: MIT Press, 1977), p.310.

suppliers to try to enter the markets. If the technology is difficult to imitate or is well protected by patents, new entry by such firms will be forestalled for a certain period of time.[53] But no technology is so complex that its imitation can be indefinitely postponed. Either the patient protection expires or it is legally circumvented by a number of means. Thus, the presence of high rent will inevitably induce competing firms to develop technologies that are substitutes for the original innovation. Sooner or later, as these firms enter the market place, the rents accruing to the innovating firm will be driven down. The same scenario holds good in relations between multinational firms and India as well as US firms in relation to Indian firms.

The net result of the dynamic factors affecting supply of and demand for technology is that two opposing tendencies confront developing nations in search of industrialization. The first, on the supply side, is that the price of any particular technology, is, over time, likely to decline and its availability, in terms of numbers of alternative sources of supply, to increase.[54] The second, on the demand side, is that as a nation's industrial base grows, the composition of technologies sought after is likely to shift from competitively-priced, mature technologies towards monopolistically-priced newer ones.[55] For rapidly industrializing nations, the second tendency runs more quickly than the first, so that as the internal technological capabilities grow, the bill for imported technology grows even faster.

This leads to a paradoxical situation: developing nations that industrialize most rapidly and expand their own technological base are likely to become increasingly dependent upon monopolistic foreign sources of technology for continued economic growth

53. Richard S Eckaus, Appropriate Technologies for Developing Countries (Washington D.C., National Academy of Sciences, 1977)p.73

54. Ibid., pp. 76-78

55. Ibid, n. 49., p.64

ultimately, as a growing nation builds its own capability to develop new technology, this dependency will diminish, but not necessarily disappear.[56] (Japan is an example) Indeed, all of the industrialized nations of the West, including the FRG and the US are dependent upon one another for the development of new technology. Instead of technological independence, the consequence of its own technological capabilities might instead increase the dependence of a developing nation on the developed countries.[57] Such a relationship between US-FRG and India seems to be the scenario of the future.

Efforts by Indian Government to Regulate the Terms of Technology Transfer

Despite viability of a relationship of inter-defensive in technological and economic cooperation particularly between US-FRG and India, it has to be admitted that foreign investment in India (therefore also the technology transferred) has been abysmal. US investments in India total a mere 600 million dollars in 1991-92.[58] In 1989, private foreign investment in India was of the order of 170 million US dollars.[59] In the case of China, it was 2.3 billion US dollars[60] (even in the year of the Tiananmen Square massacre in 1989 when western powers had attempted to reduce the flow of foreign investment into China). Foreign investment in much smaller countries in South East Asia was several times larger than in India. In 1989 foreign investments in Thailand, Indonesia and Malaysia were 1.10 billion, 700 million, and 650 million US dollars respectively. It will take time and effort for India to reach the same level of investment flows.[61]

Further, if one observes investment flows in the world, one sees that MNCs do not

56. Ibid.

57. Ibid.

58. PN Dhar, Industrial Policy: A Panel Discussion (New Delhi: Vikas, 1990), p.26.

59. Ibid.

60. Ibid.

61. Ibid.

account for more than 30 or 40 per cent of international equity investment and they are really specialized in quite a small number of industries, such as automobiles, oil, non-ferrous metals and so on. In all other industries it is really the small and medium firms that predominate; and the reason they invest is because they are specialists. It is these specialist firms that are most reluctant to come to India, because they feel that in order to exploit the full potential of their technology and skill they need to have management control.[62]

The Indian industrial policy of 1991, and subsequently 1992, have tried to give more control to the investing firms. The Industrial Policy of 1991[63] declared that even though the Government of India would continue to follow the policy of self-reliance, there would be greater emphasis on building up Indian ability to pay for imports through its own foreign exchange earnings. The government was also committed to the development and utilization of indigenous capabilities in technology and manufacturing as well as their upgradation to world standards.

The Government of India also expressed its desire to pursue a sound policy framework encompassing encouragement of entrepreneurship, development of indigenous technology through investment in research and development, bringing in technology, dismantling the regulatory system, development of the capital market and increasing competitiveness for the benefit of the common man.

Further, foreign investment and technological collaboration was to be welcomed to obtain advanced technology, increase exports and to expand the production base. Interestingly, the government profiles a picture of open competitiveness as regards

62. n. 44, pp.78-9.

63. Announced by Ministry of Industry Government of India, on 24 July 1991 (New Delhi: FICCI, 1991). MIMEO

manufacturing, except in cases of strategic or military considerations.

Industrial licensing is to be abolished, except in the case of specific industries for security and strategic reasons, social reasons, environment and articles of elitist consumption.[64] In such cases, compulsory licensing provisions would continue.

Where transfer costs are concerned, the expected remuneration must be at least equal to the costs incurred in making the transfer, without even considering the cost of the technology itself. But contrary to what the patent theory implies, even the transfer of data does not take place at no cost.[65] Sometimes, it is even costlier.[66] High technology transfer is an indicator of a cause or effect of a strong politico-economic-strategic relationship. Thus high technology transfer and economic and political relations between the US and India are interdependent. Each has implications for the other. It is important to note also that the distinction between economic and military significance has been difficult to apply in the high technology area.[67]

Indo-US economic and commercial relations have deep roots. US presence has been in evidence in many areas of the Indian economy, beginning with the flow of US assistance to India in 1951. In recent years, the US has emerged as India's largest trading partner as well as a major collaborator in joint ventures and technology transfer agreements. Until the late 1970s, economic and commercial relations had grown quite slowly.[68] Indo-US

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64. Notification issued by Ministry of Industry, Dept. of Industrial Development (No. 10(43)/91-LP).
65. DM, Lamberton, ed., Economics and Information and Knowledge (Harmondsworth: Penguin, 1971), p.225.
66. DJ, Teece, The Multinational Corporation and the Resource Cost of International Technology Transfer (Cambridge: Ballinger, 1976), p.36.
67. A. Clark Asa & John F. Lilley, ed., Defense Technology (New York: Praegar, 1989), p.76.
68. Report of the US-India Business Leaders Conference, 11-13 May 1987 (Washington, D.C.) FICCI: New Delhi. 1987), p.11.

politico-economic and technological relationship can be divided into four major segments namely: Aid, Trade, Investment, and Technology Transfer.

Aid

In an appearance before the House Foreign affairs Committee in February 1983, Secretary of State George Schultz stressed the military and security aspects of development programmes.[69] Shultz then moved on to base would peace and military security on economic well-being in the developing countries.[70]

In the introduction to the Overseas Development Council's annual (1983) assessment of the state of US foreign policy vis-a-vis the Third World, Robert S. MacNamara, after emphasizing the importance to the US economy of Third World growth and well-being, stressed another aspect of development, namely the humanitarian imperative.[71] That basically a peaceful world cannot be built on inequities.[72]

Two steps to deal with deteriorating conditions in Third World countries were: (1) to allow them to have a greater say in the working of the international monetary system; and (2) for the US to take the lead in mounting an attack on the worst forms of absolute poverty throughout the world. This would involve increases in concessional aid to developing countries.[73]

It is beyond the scope of this study to go into the particularities of the entire

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69. Statement by George Shultz before the Foreign Affairs Committee, US House of Representatives, 16, February 1983.
70. Ibid, pp.7, 9.
71. Robert S McNamara quoted in John Plewers and Valeriania Kallab, eds., US foreign policy and the Third World: Agenda, 1983, ODC (New York: Praeger, 1983), pp.2-3.
72. Ibid, p.2.
73. John Swell, Remarks at the International Development Conference, Washington D.C., 19, May 1983.

concessional assistance provided by the US. The intention is eventually to link up US aid with emphasis on science and technology and transfer of technology to India.[74]

Though the US contribution was the largest in absolute terms, it fell to next to last, 0.27 per cent in terms of share of its gross national product (GNP).[75] Other mechanisms, such as the Economic Support Fund, have a security rationale for going beyond the because they support countries that are excluded from AID' development assistance because their income levels are too high.

AID: Aspects of Science and Technology for Development

Science and technology received increased emphasis in the AID programme of both Presidents Jimmy Carter and Ronald Reagan, According to AID estimates, in the FY 1985 request for development assistance funds, $446,000,000 or 28 per cent of the total were for science and technology. Of this amount, $264,000,000 was for research amounting to more than double of AID's research budget since FY 1980.[77] Technology transfer, development and adaptation is one of the four major policy priorities, supported by a Central AID Science and Technology Bureau established in 1981. Scientists and engineers are likely to find this desirable.

A review of US foreign aid legislation up to 1979 indicates that there is no explicit mandate for helping to build indigenous science and technology capability in other

74. The Commission on Security and Economic Assistance: A Report to the Secretary of State, Dept. of State, Washington D.C. November 1983.

75. US Foreign Policy and the Third World: Agenda 1983 in n.71,

76. The President's Industrial Innovation Initiatives, (Office of the White House Press Secretary, Washington D.C., 1979), 31 Oct. 1979

77. US Agency for International Development Congressional Presentation for Fiscal year 1985, Main vol., pp.260-62.

countries.[78] The Reagan Administration's AID strategy was only compatible with the congressional mandate if one is willing to accept a philosophy of long term, indirect as well as direct benefits to developing countries. Jean Wilkoweski, the US ambassador to UNCSTD in the Carter Administration stated the same:

> UNCSTD has taught us that the overriding objective in the application of science and technology is to further the modernization of developing economies and simultaneously to meet the basic human needs of developing country populations. It cannot be either or, it has to be both simultaneously. The two can and should proceed simultaneously in a mutually enforcing relationships.[79]

From the preceding projections it appears that AID programmes are a peculiar mix of individual preferences by agency personnel, and of Congressional and administrative priority settings. At present, development assistance activity within AID is heavily oriented towards agriculture, with some activity in health, education and energy. In the FY 1985 AID budget request 64 per cent of science and technology and 72 per cent of research activity came under the heading agriculture, rural development and nutrition.[80]

The phrase "technology transfer" has been used in connection with one of AID's four main policy thrusts. However, AID does not seem to emphasize strongly the transfer of industrial technology within its science and technology activities. First, such transfer is not deemed in the US economic interest. Second, it is inherently difficult to transfer industrial technology through the mechanism of a government aid programme.

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78. Robert P Morgan, Science and Technology for Development: The Role of US Universities (New York: Pergamon, 1979), p.23.

79. Jean M Wilkoweski, "Science and Technology for Development: Myth or Reality", paper presented at International Development Conference, Washington D.c., 19 May 1983, p.4.

80. US Agency for International Development Congressional Presentation, FY 1985, Main vol., p.261.

Technology and science cannot be neatly packaged and disbursed like other foreign aid commodities. Baranson sees operational technology continuing to be "the products of enterprise units linked to technology generating units".[81] Industrial technology transfer would appear to take place primarily through commercial channels and thus divorced from AID.

Another issue is the extent to which the United States is prepared to assist or cooperate with developing countries in such science and technology areas as can be characterized as high technology. Clearly, some such activity goes on when students from other countries come to study science and engineering in the US. Furthermore, high technology is not necessarily excluded from traditional AID areas, such as agriculture and health. There is probably no simple way to resolve this issue; political and security considerations are likely to play an important role, with decisions being made in some cases on a country by country basis through bilateral agreements.[82]

Concerns about leakage or haemorrhage of technology to the Soviet Union became more prevalent in the Reagan Administration, leading to withdrawal of US Government support for the International Institute of Applied Systems Analysis (IIASA) a joint US-USSR activity located in Austria, and to attempts to increase restrictions both on exports and on scientific communication.[83] While these concerns generally do not get aired in connection with programmes involving developing nations, they might possibly have some relevance because developing countries could conceivably serve as conduits for technology from one nation to another. (This became a source of concern as regards India

81. Jack Baranson, North-South Technology Transfer, (Mt Airy, MD: Lomond, 1981), pp.3-5.

82. Robert Morgan Science and Technology for International Development (Westview, Colorado: 1984), p.119.

83. Mitchell B Wallerstein, "Scientific Communication and National Security in 1984", Science 224, 4, Washington D.C. May 1984, pp.460-66.

in the Super Computer deal detailed later in the Computers Case study).

Collaborative research aid development makes a great deal of sense as countries develop and increase their indigenous capability. It also lessens the need for a large US overseas presence. Yet, this has never received much emphasis in US science and technology for development programmes. In all the AID projects there is overwhelming need for continuity and constant evaluation.

US Agency for International Development (USAID) contributions to the economic development of India are provided through assistance programmes. Total US economic assistance to India from 1951 through 1988 was $12.5 billion Table I give the breakdown:[84]

Table I
US Bilateral Economic Assistance to India

(US $ million)

US Fiscal Year	Amount Committed
1951-1977	10,238.1
1978	215.1
1979	272.3
1980	246.4
1981	299.5
1982	251.5
1983	219.8
1984	215.3
1985	179.8
1986	178.2
1987	126.9
1988	123.9
1989	126.2

Note: Bilateral assistance includes (a) development loans, (b) development grants, (c) PL 480 food aid excluding ocean freight and aid provided through the World Food Programme, (d) other grants, (e) disaster assistance, and (f) US Export-Import Bank loans (net).

Source: US AID FOLIO, NEW DELHI, 1989

84. USAID FOLIO, New Delhi, 1989.

US programmes for bilateral economic assistance to India for FY 1988 included $20.2 million in development assistance; $76.2 million in PL 480 Title II food aid grants; and $27 million as other food aid grants under Section 416 of the US Agricultural Act. USAID programmes are related to India's development goals and priorities. Currently, keeping in mind India's stated goals, the focus is on collaborative work in science and technology. The PACT project (Programme for Advancement of Commercial Technology) comes under this rubric. The PACT project has a $10 million technology development fund established to co finance the pre-production R&D costs of innovative products and processes through Indo-US joint ventures in R&D. As of June 1989, 20 sub-projects and two feasibility studies, involving PACT financing of %7.2 million, have been approved. Under the Programme for Acceleration of Commercial Energy Research (PACER), a joint programme launched by Government of India and USAID, the latter will make available $20 million. Other ongoing projects in health and bio-medical research are being supported as well.[85]

Trade: Trade has a commercial connotation and yet it is loaded with political overtones. The US continued to be India's largest trading partner in 1988, and the most important source of foreign investment, joint venture collaborations and technology transfer. The total value of bilateral trade, after being around $4 billion from 1983-88. In that year, the US accepted 25 per cent of India's exports and supplied 10 per cent of its imports. Indo-US bilateral trade had steadily risen. In 1988 it was over five and a half billion dollars. Since 1983 India has been enjoying a trade surplus in relation to the US. It came to $669 million in 1988.[86]

The following table is on bilateral trade since 1980:[87]

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85. Ibid.

86. Ibid.

87. US Dept. of Commerce, May 1989.

Table 11
Indo-US Trade US $ Million

Year	India's Exports to the US	India's Imports from the US	Two-way trade	Trade Balance
1980	1097.6	1689.4	2787.0	(-) 591.8
1981	1202.1	1747.5	2949.6	(-) 545.4
1982	1403.8	1598.5	3002.3	(-) 194.7
1983	2191.4	1827.8	4019.2	(-) 363.6
1984	2515.5	1569.6	4121.1	(-) 981.9
1985	2478.3	1641.9	4120.2	(-) 836.4
1986	2464.6	1536.0	4006.6	(-) 928.6
1987	2761.5	1463.7	4225.2	(-)1297.6
1988	3167.0	2497.9	5664.9	(-) 669.1

While Indian exports to the US registered an increase of 16.8 per cent in 1988 over the previous year, there was a sharp increase in India's imports from the US by as much as 71 per cent. India's imports have gone up in high-tech areas, while its exports are diversified among a wide-range of products gems, jewellery, garments, engineering products and leather goods. India is now one of the largest exporters of small, polished diamonds. Tables III A and III B provide the figures for six major commodities traded with the US in 1988:[88]

Table III A
Import-Export Trade Composition: 1988)

Major Indian Exports to the US	US $ Million
Diamonds	997.7
Garments	507.6
Engineering products incl. electronics	233.7
Petroleum & petroleum products	225.2
Textiles	167.4
Carpets & Floor coverings	128.0

88. FICCI, Working paper on Indo-US Trade, (New Delhi) August 1988. (Unpublished)

Table III B
(Major Indian Imports from the US)

Transport Equipment	414.5
Cereals	289.0
Fertilizers	211.5
Industrial machinery	143.6
Power generating machinery	128.4
Electronic equipment	121.2

Source: FICCI, August 1988.

As far as the Generalized System of Preferences goes, India's exports covered under this scheme have increased from $290 million in 1987 to $349 million in 1988. Over 4,100 products are eligible for GSP. Though the trade deficit in 1988-89 grew to $7.1 billion as imports jumped approximately 15 per cent in dollar terms, exports increased by more than 18 per cent, but on a smaller base. US exports to India, led principally by high technology goods, aircraft and foodgrains, grew by an impressive 70 per cent and overall bilateral trade by 34 per cent. Foreign direct investment increased approximately $250 million in 1988-89, up from $150 million a year earlier.[89]

In September 1989, a landmark agreement was signed in New Delhi by the Indian and US Government for the avoidance of double taxation and the prevention of income tax evasion. Lengthy negotiations, spanning almost 30 years, preceded the agreement.[90] Politically, this should generate better atmosphere for bilateral trade and make transfer of technology easier. Dividends, interests, royalties and fees for services related to the transfer of technology and other specified services will be taxed in the source country at concessional rates.

89. Business America, (Washington D.C.) 9 Oct. 1989, p.19.

90. Span (New Delhi) January 1991, p.22.

The Indian Government is encouraging production, improved quality and increased competitiveness overseas. Many US firms eg.,. Motorola, Texas Instruments, Digital Electronics Corporation (DEC), are exploring and developing business opportunities, particularly in higher technology areas such as electronics, computers and telecommunication equipment. However, on 25, May 1989 the US named India, under super 301, as a trading partner with practices which fall within US trade liberalization negotiating priorities. The US decided to initiate investigations into India's investment regime and also named it on the US 'priority watch list' for practices related to the protection of intellectual property rights.[91] There has been a series of negotiations concerning patents and property rights which will be detailed in the case studies. The US now seeks to negotiate to eliminate any malpractice.

In spite of all this, the US is now firmly established as India's leading trading partner as preceding figures show. US high technology exports reached $537 million in 1987, up 17 per cent from 1986. In 1988, the US government export license approvals for electronics, computers, and telecommunications equipment to India also increased sharply. Some 2,970 licenses applications valued at more than $703 million were granted, compared with 710 licenses valued at $22.7 million in 1983.[92]

Joint Ventures and Investments

Technology transfer is definitely an area of dramatic progress in Indo-US relations, especially in high technology and defence items. India is today the sixth largest importer of US technology, having overtaken several NATO countries in this regard. Since the

91. Economic News, May 1990, New Delhi, USICA, pp.5-6
92. Business America, 9, Oct. 1989, p.20.

signing of an Indo-US memorandum of understanding for technology transfer in November 1984, the volume and value of high-tech merchandise licensed for export to India has increased five-fold. The US is India's leading partner in joint venture, technology transfer agreements, and investments, as indicated in Tables IV and V 93

Table IV
Approval of US Investment in India (Rs. Million)

Year	Total Foreign Investment All countries	US Investment
1980	89.24	21.69
1981	108.71	22.48
1982	628.06	50.33
1983	618.73	138.92
1984	1130.02	89.50
1985	1260.66	399.25
1986	1069.52	293.70
1987	1077.89	295.15
1988	2397.57	971.37

Source: India Investment Centre, 1989

Table V
Approval of Indo-US Industrial Joint Ventures

Year	Total	Financial and/or combined tech/ financial	Technical	Investment (Rs.Million)
1980	125	19	106	21.69
1981	85	15	70	22.48
1982	110	24	86	50.33
1983	135	32	103	138.92
1984	147	36	111	89.50
1985	197	66	131	399.25
1986	189	71	118	293.70
1987	196	57	139	295.15
1988	191	120	71	971.37

Source: India Investment Centre, 1989

In 1988, the US share of investment in India was over 40 per cent of its total foreign investment. The stock of US foreign investment is largely concentrated in chemicals, pharmaceuticals, fertilizers electronics. US companies account for the largest number of new collaborations with Indian firms, and the greatest annual investment value. Non-resident Indians, most of whom reside in the US, invested a large amount back into the country. India's relaxation of its industrial licensing policy will result in continuing improvement in the prospects for further joint ventures. Among the likely areas are computer equipment, software, electronic components and automotive parts.

Analysing the profile, one sees that the US continues to lead the list of joint venture "collaborating" countries, with 191 new project approvals in 1988, followed by West Germany, the United Kingdom and Japan. The Indian Government approved US equity investment worth $70 million in 1988. Actual investment in 1988 increased more than three fold compared with 1987, almost equal to the entire amount of $83 million approved in 1987. The Indian Government continues to favour foreign collaborations which involve transfer of know-how to India, particularly in high technology areas. Despite these encouraging trends, investments and joint venture approvals still face significant bureaucratic and policy hurdles, and total foreign investment in India remains exceptionally small by international standards.

High technology is technology that makes a contribution to the current state of the art.[95] Therefore, its rate of obsolescence is high, innovation is fast and its commercial competitiveness high as well.

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93. India Investment Centre Document in Foreign Investments, New Delhi, 1989.

94. Ibid.

95. John Martens, A "Western Exports of High Tech. Products to Communist Countries", Office of the East-West Policy and Planning (Washington D.C., U.S. Dept. of Commerce), Feb. 1982, pp.1-3.

Unlike in West European industry, the commercial aspect of defence technology transfer is of relatively less importance in the USA The benefits to the defence industry from exporting weapons play an insignificant part in this policy. Less than five per cent of the total US defence production is exported. For the US, control over the transfer of high-technology goods and knowledge to other nations is a tangible weapon, employed overtly as well as covertly to influence the foreign and domestic policies of the nation concerned, to suit American perceptions.[96] Further, the US perceives its national security as heavily dependent on the wise application of its impressive scientific and technological capability. Three major factors affect US national security science and technology.[97]

1) The momentous political changes in the Soviet Union and Eastern Europe, in the wake of 'new thinking' replaces the monolithic eastern bloc military threat to which American defence technology had been directed for almost half a century, with the perception of a more complex, variegated and uncertain threat. Technology will be one of the nation's chief hedges against the uncertainties of the future.

2) At the same time, the American dominance of virtually all fields of technology, especially defence technology, during the post-war period is giving way to a position of first among equals. The US Defence Department (DOD) consequently has learned to share technological advance wherever it takes place, whether in the non-defence sector or in other countries.

3) Finally, the DOD has increasing difficulty in selecting, procuring and managing the technology upon which it depends.

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96. Philip A, Roberts, Technology Transfer: A Policy Model (Washington D.C., National Defence Univ. Press, 1988) pp.37-9.

97. Ashton B Carter, and William J Perry, "New Thinking and American Defense Technology" in Eric H., Arnett, ed., Science & International Security (Washington D.C., AAAS, 1990),p.34.

With the waning of the Cold War and the changing international relations, technology will paradoxically become more, not less, important to US national security perceptions.[98] Thus US perceptions point to forging a stronger relationship between defence and the technology base to the benefit of both sectors.[99] The DOD is shrinking in importance in its contributions to the global pool of technology. The only way for DOD to incorporate the state of the art technology in its weapons systems is to learn to borrow technology from the commercial world. Conversely, defence technology has an impact on the commercial performance of high-tech US firms. This, too, is important. This inevitably involves the DOD in sensitive relationships with foreign generators of technology.

A less sudden but comparably profound change has taken place in the global technology base. Private industry has been increasing its expenditures on R & D faster than the federal government, and in particular, the DOD. R & D spending by US industry has quadrupled since 1960 in real terms, while federal spending has merely doubled during the same period. During this time, R and D investments to the global technology base has correspondingly declined. Thus in 1960 DOD accounted for half of all US R & D spending, but by 1990 its spare had shrunk to one-third.[101] This decline occurred despite the defense build-up of the late 1970s and 1980s. Even more striking is the decline in DOD's share of total spending on science and technology in the Western world. Thirty years ago, the US DOD funded fully one-third of all the R & D performed in the West; now it funds one-

98. Daniel Dendney and G John Ikenberry "Who Won the Cold War?" Foreign Policy, (Washington D.C.), no.87, Summer 1992 p.137-138.

99. Report of the National Critical Technologies Panel, (Washington D.C., U.S. Govt., March 1991), p.1

100. Stuart Gannes, "The Goods News about US R and D", Fortune, (New York) 1 February 1988, p.49.

101. Under Secretary of Defence (Acquisition)Assistant Secretary of Defence/Production & Logistics), Report to Congress on the defence Industrial Base, November 1991; p.4-1.

sixth.[102] In some high technology sectors, the diminution of the role of the defence department is even more striking. DOD was a major supporter and purchaser of micro-electronics technology in 1960. Now it is a relatively minor player in this fast moving technology, used in both children's toys and missile guidance systems. A concomitant has been the erosion of the across-the-board dominance in technology enjoyed by American commercial firms in the post-war period.[103]

As For technologies of broad use to society as well as defence (for example, information technologies), the message is clear. Advanced information technology is profoundly changing global competition, commercial and military, in such fields as semiconductors, computers, fibreoptics, robotics, office automation, globally integrated financial trading systems, military C^3I (Command, Control, Communication and Intelligence) smart weapons and electronics.[104]

Thus US high-tech transfers to India too fall within the ambit of defence as well as commercial technology transfers, and follow a pattern of commercial trade and investment, economic aid and technologies spawned in the commercial sector, with the spin-offs in the military sector.

Though defence R & D expenditures have declined in relative importance over the past 30 years, they are still large. Defence is thus still a major potential source of new technology for the commercial sector. The US has no central ministry of science and technology. Therefore DOD and the commercial sector have to be symbiotic in technology osmosis. This is both an advantage and an obstruction in US transfer of high technology.

102.House Armed Services Committtee, FY 1990 Authorization Report Washington D.C.

103.Ibid.

104.CH Fergusen, "America's High-Tech Decline", Foreign Affairs (New York), Spring 1989, p.123.

Because both DOD's perception of itself as a technological leader and the commercial US high-tech firms' operations mainly on profit, render transfer of high-tech to India a difficult proposition.

One of the main areas of control over high-tech in the US in defence is the COCOM. The US is the only nation which uses the COCOM export control mechanisms strongly for foreign policy purposes.[105]

These policies have become a source of considerable political tension, because nations often seen aggressive US application of extra-territorial contracts our re-export as clandestine attempts to gain a trade advantage under the guise of security concerns..[106] These restrictions certainly inhibit the commercialization of defence-related technologies.

The US nervousness is evident, despite the thaw in international relations initiated by Mikhail Gorbachev, former President of the now defunct USSR, in exercising technological controls through COCOM (Coordinating Committee on Multilateral Export Controls,), based in Paris. This organization administers uniform (in principle) multilateral national security export controls on products and technologies related to nuclear energy, and to dual use (products and technologies that can be used for military as well as peaceful purposes). The COCOM dual-use list, known as the 'Internal List' comes three types of products (National Academy of Sciences, 1987):

1. Items designed specially or used mainly for the development, production, or use of arms, ammunitions, or military systems (AAMS).

105.Michael Mastanduno, "The Management of Alliance Export Control Policy; American Leadership and the Politics of COCOM", in Gary K. Bertoch, ed., Controlling East-West Trade and Technology Transfer: Power, Politics and Policies, (Durham: Duke University Press, 1988), p.275.

106.Hearings Before the Subcommittee on Science, Research and Technology 10th Congress. 6, 21, 22 feb., 8 March 1990, no. 109. (Washington D.C.) pp 94-98.

2. Items incorporating unique technology, the acquisition of which might be especially helpful in the development or production of AAMS.

3. Items in which proscribed nations have a deficiency that hinders development and production of AAMs, where the deficiency is not likely to be overcome within a reasonable time period.[107]

Each of the NATO countries (excluding Iceland) and Japan require export licenses for the controlled items to be shipped to countries that do not belong to COCOM, and to which such exports are prohibited. In USA, the Export Administration, a part of the Department of Commerce Administers the controls over US exports of dual-use items to foreign countries and over re-exports of these items to other countries.[108]

The above is merely to emphasize the fact that transfer of high technology, even more than other technologies, depends on the political climate and international relations and is, therefore, an intrinsic part of a nation's foreign policy.

Its impact on India is significant. Of the $2.5 billion worth of total US exports to India in 1988, high technology items accounted for over one-third, i.e., $870 million. It included aerospace, data processing, telecommunications, micro-electronics, machine tools and robotics, scientific instruments and medical equipment sectors. Out of $870 million, $685 million (over three-fourths) were controlled goods and technology exported under US individual validated license, i.e., under a license requiring prior, written government approval for each shipment.[109]

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107. Toufiq A Siddiqi, "Factors influencing the transfer of High Technology to the developing countries", in Manas Chatterji, ed., Technology Transfer in the Developing Countries (London: MacMillan, 1990). p.155

108. U.S. Department of Commerce, Bureau of Expert Administration, BXA Today (Washington D.C., 1992) p.1.

109. Indo-USA (New Delhi) March 1991, p.9.

The total percentage of controlled US high-tech exports is actually even higher, when one taken into account those included under general or special licenses or service supply license. There is now a relatively liberalized attitude to US export licensing but there is a rider to this: India must strengthen its own national export control system and then it shall get an even more liberal treatment from the US[110].

The current status of COCOM vis-a-vis India is that three out of seven controlled items have been partially or entirely decontrolled and the other four substantially liberalized. Decontrolled items include crystalline materials and devices, computers (partially), transistors, dice and wafers (entirely); and those substantially liberalised, electronic devices, non-military aircraft/helicopters and radio relay equipment.[111] But sensitive items do come within the missile and technology control list.

The latest Asian nation to get on to the US export list, consistent with provisions of Section 5F of the Export Administration Act, which has a parallel trade regime to that of US, is Hong Kong, making US firms more viable for operation and strengthening commercial ties.[112]

On the commercial side, besides export licensing, two major forms of controls exist on technology transfer: i) patents and 2) intellectual property rights.

1) Patent: This concerns a patent jointly taken out by a foreigner and a national with a view to local exploitation of an invention, when the foreigner owns a patent valid in another country and the classic patent does not exist in the country concerned. This is to ensure that the technology transferred by contract would protect the joint

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110.Interview with Mr. Bruce Cromack, Department of Commerce, Washington D.C., 29 September 1992.

111.Department of Commerce Dual-use Control List (Washington D.C., 1992)

112.Business America, 18, Nov. 1991.

enterprises concerned for the national exploitation of new inventions.[113] In Indo-US technological transfer, the US trade officials have warned India of retaliation under the Special 301 provisions unless it changes its patent laws, especially in the area of pharmaceuticals.[114]

2. Intellectual Property Rights mainly protect the technological trade interests of the transferer of technology. It is an extension of patents. The US made special 301 an instrument to enhance the administration's ability to assess market access, and effectiveness of protection of intellectual property rights by US partners.[115] This is within the jurisdiction of the Omnibus Trade and Competitiveness Act of 1988. And those that were named on the ''priority watch list'' were China, India, and Thailand. Following investigations concluded within six months action was to be taken. India gained a reprieve but is still being `watched'.[116]

From the preceding framework, it is easier to understand US policies and precepts towards high-tech transfer to India. Until 1985, two-thirds of India's defence technological cooperation was with the Soviet Union and much of the rest with Western Europe. Indo-US technological dialogue between 1986 and 1989 involved, among other things, the transfer of three main items: advanced aeroengines for the development of a light combat aircraft (LCA); satellite and booster rocket technology for India's space programme; and supercomputers for weather forecasting. All three items were at the forefront of US defence and civilian technology.

113.A. Jason Mirabits ''Technology Transfer of Patent/Data Rights in the Commercial Sector: A Primer'' in Portfolio: International Economic Perspectives Vol.12 no.1 (Washington D.C. U.S. Govt, 1988) p.252

114.Times of India, (New Delhi) 12, Dec. 1991.

115.Economic News (New Delhi), June 1991.

116.The Times of India, 29 May 1993.

At a wider level, the question of US transfer of high-technology to India becomes relevant for both defence and development. The Indian search for advanced technology is mainly for domestic economic development. Indian negotiations for the same are in the context of North-South relations, while the US, wary of India's ties with the Soviet Union, viewed the transfer in East-West conflictual terms.[117]

In the debate on defence versus development the US per option has been that India needs only appropriate technologies for the development. These call for labour-intensive technologies of rather low levels. Therefore, the surmise has been that advanced technologies asked for by India must necessarily be for defence.[118] Therefore, substantially different qualitative standards of technology might be deemed appropriate in the defence context.

The Pakistan counter in defence acquisitions from the US has played an important role. The US F-16 combat fighter, TOW anti-tank missile, the hand-held stinger surface to air missile, all supplied to Pakistan have provoked India into purchasing compensating military hardware from Western Europe.[119] The added factors were of course the 1962 Sino-Indian conflict, the 1965 and 1971 Indo-Pakistan wars. Considering the fact that weapons transfers and defence technological collaboration among states that perceive common security concerns have often led to collaboration in the civilian economic and technological sector as well, US relations with India has showed little evidence of this.

Meanwhile, as already observed, beginning around the mid-1970s, US trade with, and

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117. Raju, Thomas, "US Transfers of "Dual Use" Technologies to India", Asian Survey, (Berkeley) vol.xxx,no.9, Sept. 1990, p.826.

118. John V. Granger, Technology and International Relations (San Francisco: W.H. Freeman 1979), pp.100-106.

119. "US Steps up movement of High Technology to India", USIS Press Release, (New Delhi) 10 Nov. 1985.

investments in India have grown at a fast pace, establishing the US as India's leading partner and foreign investor. A decade later, Indo-US defence collaboration commenced with the signing of the Memorandum of Understanding in 1984, signed by President Reagan and Prime Minister Indira Gandhi, thus establishing US military ties with India.[120] This has emphasized security of transfer of advanced civilian technology to India and technological ties, with the US based on "mutual benefit and scientific merit". This is a change from the earlier transfers of high-tech, which were more in the context of East-West tensions and the price that India was expected to pay was a compensating reduction in its technological and military ties with the Soviet Union.[121]

Continuing this process of change, in 1986, a high level Pentagon delegation, led by Secretary of Defence Caspar Weinberger, visited New Delhi to negotiate the transfer of military and military-related technology from the US to India.

Relations between India and the US have always been complex, caught in a cycle of conflict and cooperation even though India is a democratic state with the same political values as the US. Though India was the largest recipient of US economic aid during the decade before the 1965 Indo-Pakistan War, it is only since the mid-1970s that US foreign investments and Indo-US trade have been increasing. On the other hand, the US has been the main source of lethal military supplies to India's main adversaries, Pakistan and China. India reacted with anger and hostility during the 1965 Indo-Pakistan war when American arms were used against it,[122] and the American US Enterprise adopted a threatening posture in the Bay of Bengal during the Bangladesh crisis, supplementing the Nixon-

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120. AD, Krantz, Indo-US Agreement on Advanced Technology projects, USIS Press Release, 19, Sept. 1985.

121. Charles H Percy, "South Asia's Take-off", Foreign Affairs (New York) Winter 1992/1993. p.171

122. Hindustan Times (New Delhi), 12 Oct. 1986.

Kissinger ''tilt'' towards Pakistan.[123]

While the political ''dips'' of 1965 and 1971 were the outcome of ''high politics'' relating to military affairs, there were also ''dips'' arising from ''low politics'' relating to economic affairs.[124] In the 1960s, large scale US foreign aid to India ironicallyexacerbated mutual relations. The Americans expected a sense of gratitude and perceived its absence in India's attitude. India, on the other hand, perceived American efforts as manipulating India's domestic economic policy.

In 1989, the US decision to include India, along with Japan and Brazil, in the Super 301 provisions of the 1988 US Omnibus Trade Act, produced yet another downturn in Indo-American relations.[125] India had refused to comply with American demands to open up its insurance and investment markets to foreign entrepreneurs, arguing that such decisions must be resolved in multilateral fora, such as the Uruguay Round of Trade Talks set for December 1990. Moreover, India had a trade surplus of only $850 million with the US, while the latter had a deficit of $49 billion with Japan.[126] In any case India insisted that it would not negotiate under such threats of economic retaliation.

The Super 301 imbroglio was expected to affect seriously US technology transfers to India, since the Bush Administration was expected by law to cut off all trade ties unless New Delhi complied with the provisions of the US Trade Act. However, in June 1990, India was taken off the list, following the removal of both Japan and Brazil.[127] The reason for the US decision was not clear since India had refused to bend on the issue, but there had

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123.HW, Kissinger, White House Years (New Delhi: Vikas 1979), p.842.

124.Robert Keohane, and Joseph Nye S, Power and Interdependence: World Politics in Transition (Boston: Little Brown, 1977), p.24.

125.News India, 4 May 1990.

126.Ibid.

127.Economic News, (New Delhi), June 1990.

been pressures on the Bush Administration from US corporations with investments in India, especially Pepsico which had been allowed into the Indian investment market, not to antagonize India at a stage when it was liberalizing its economy.

On the other hand, the Indo-American relationship was not one of hostility either. Relations were cool during the Eisenhower and Carter Administrations and friendly at times during the Kennedy and second Reagan Administrations.[128] Indeed, the "peak" was the signing of the Memorandum of Understanding (MOU) soon after the meeting between President Reagan and Prime Minister Indira Gandhi at Cancun in 1981. This moderately "negative-positive" fluctuating relationship was reflected in the nature of the Indo-US military and technological cooperation that existed in the decades before the November 1984 MOU and the follow up 1985 procedural implementation agreement. Except for the brief period in the aftermath of the 1962, Sino-Indian war, when some light arms and ammunition were rushed to India and an Indo-US joint air-naval exercise was conducted, there has been virtually no US weapons transfer to India or any other form of military co-operation between the two countries.[129] In fact, in the pre-1985 period, Indo-US cooperation in science and technology was restricted mainly to low visibility, although not necessarily, civilian sectors such as agriculture, animal husbandry, forestry and agriculture, health and biological sciences; and environment and ecology.[130] This was in direct contrast to the large scale transfer of American weapons to Pakistan in the 1950s under the SEATO and CENTO defence pacts and then again in the 1980s following the Soviet invasion of Afghanistan[131]

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128. Ibid, n. 105 p.839.

129. Ibid.

130. Indo-US Cooperation in Science and Technology, US Embassy Report, New Delhi, 1986-87.

131. Paul, Kreisberg, "The US, South Asia and American Interests", Journal of International Affairs (New York; Columbia University, 1989), p.83.

In fact, US perceptions of India going so far as to consider a minimum probability of India attacking US forces if Indian resentments against the US reached a high note,[132] seems an unlikely and improbable scenario. Yet, according to US perceptions again, Indian security, policy as it may affect US interests, has three important components: build-up of military technology to enhance national prestige and aggrandize the military, while countering threats from Pakistan and China; weakening of security guarantees to Pakistan, including initiatives and postures that might undercut the historically unreliable Chinese and US commitments to Pakistan's security; and overt defiance of US "hegemony" as a manifestation of Indian aspirations for the status of a "regional superpower".[133]

In the long term, the US is likely to re-evaluate its interests in the region. Such a re-evaluation might well decrease US commitment to Pakistan in favour of a strengthened cooperative arrangement with India, wherein the two countries would share responsibility for stability in the region. The US has already been supportive of Indian peace-keeping efforts in the island states in the region and in the Gulf.[134]

The Effects of MOU and Super 301

The MOU of 1984-85 introduced substantial changes in Indo-US relations in the areas of defence cooperation and sales of military and dual-use equipment and high technology. It resulted in the immediate release of a large number of technologically advanced exports. It was followed by another significant agreement that set up "mission area discussions" between the defence establishments, of the US and India "with the goal

132.Eric, Arnett, "Technology and Emerging Regional Powers: Implications for US Interests" in Eric H. Arnett, ed., Science and International Security (Washington D.C., AAAS, 1990), p.143.

133.Ibid, p.142.

134.Op.cit.

of increasing military cooperation and sales of military equipment and technology''.[135] The immediate impact of the MOU was the approval of sales of more than $1.2 billion worth of dual-use technology in 1985, constituting more than 90 per cent of the total number of proposals put forward.[136] Defence delegations from both countries, led by their secretaries of defence, exchanged visits in 1986 to explore specific areas of cooperation.

US high technology exports reached $537 million in 1987, up 17 per cent from 1986. In 1988, US government export license approvals for electronics, computers and telecommunications equipment to India also increased sharply Some 2970 licenses applications valued at more than $703 million were approved compared with 710 licenses valued at $22.7 million in 1983.[137]

Growth in US technology transfers to India in recent years has been impressive, not merely for its sheer speed and volume but also for the nature of items being transferred, including those that were almost never transferred earlier. In particular, the sales of the Cray XMP-14 supercomputer, which was controversial, for India's meteorological department, the advanced silicon-on-saffire'' microprocessor chip for India's INSAT-2 satellite, and 16 General Electric F-404 engines to Hindustan Aeronautics for the development of the Light Combat Aircraft (LCA), constituted a major leap forward in Indo-US technological cooperation.

A brief note on the LCA is warranted here to emphasize the importance of the US transfer of technology along with that of other nations. The LCA will be contemporary in its technology and effectiveness as a weapon system of its class in relation to any of the

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135. US Department of Defence, The Technology Security Programme, (Washington D.C., US govt, 1986) p.66.

136. USIS Press Release, 22, Oct. 1985.

137. Business America, (Washington D.C.) 9 Oct. 1989, p.20.

aircrafts in service in the airforces of the world during the period 1995-2015. The important point is that most of the advanced technologies which have been proved a priori as technically and economically viable have found place in the evolution of LCA.[138] Therefore, it provides a wide basis for a range of advanced technologies.

The LCA was designed as a multirole combat aeroplane incorporating the state of the art technology in various design disciplines. It is a low weight, complex, low risk aeroplane with high survivability and maintainability. It gives an optimum balance between subsonic and supersonic performance.[139] Its aerodynamic configuration has been chosen to meet the critical operational requirements spelt out in air staff requirements (ASR) and the air worthiness requirements laid down in US Air Force Military Specifications (MIL Specs). This was mainly to incorporate key technologies from abroad; perform a renaissance in Indian aeronautics; fulfil the requirements of the Air Force; and most of all bridge the technology gap.[140] The project is now in the Project Development Phase (PDP).[141] It goes to American credit that they have shown a keen interest in the LCA project and tried convincing the then Prime Minister, Rajiv Gandhi, that the technology transfer for the LCA project would be comprehensive and cost effective. Rajiv Gandhi, on his part, expressed concern at the legal impediments preventing defence technology transfer.[142] This stage was reached after a great deal of diplomatic negotiations between the US and India.[143] On the part of India, the LCA project was a bold step trying to

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138.LCA Development Programme. Report to Indian Air Headquarters, Aeronautical Development Agency, Bangalore, 1989 (Unpublished) p.21.

139. Ibid.

140.Report of the Seventh Technical Committee, ADA. Bangalore, 4-5 Nov. 1988.

141.Aeronautical Development Agency (Bangalore), 4th Annual Report, 1988-89, p.11.

142.SA, Aiyer, "India to get US LCA design system", Indian Express (New Delhi), 15 August 1988.

143.GK, Reddy "The US team will seek to dispel misgivings", The Hindu (Madras), 10 Oct. 1986.

indigenize and develop the GTX engine while importing F-404 engines along with it.[144] The additional imports and expenses amount already to Rs.600 crores.[145] "India is now poised to accelerate the development of the LCA", stated the programme director, Dr. Kota Harinarayana.[146] It is the result of the coordinated effort of various defence research departments and transfer of high=tech from US, France, Germany and Sweden. After the production of the training aircraft HF-24 Marut, this would be the first design worked out independently.[147] Moreover, it indicates a major US high-tech transfer to India.

In a similar category is the example of the transfer of technology in the form of the Cray XMP-14 supercomputer to India. On 9 October 1987, Marlin Fitzwater said the administration had approved the sale of the supercomputer to India.[148] The sale, he said, was an example of cooperation under the Reagan-Gandhi Science and Technology Initiative (STI) and a part of "our expanding high-technology relationship with India".[149]

John W D Connolly, Director of the National Science Foundation's Office of Advanced Scientific Computing: "The way I look at it, computers are at the leading edge of high technology, super computers are at the leading edge of computers, and Cray is at the leading edge of supercomputers."[150]

One of the major obstacles to the use of the supercomputer is its cost with a sales price of $10 million to $20 million. Because of this, the US National Science Foundation has

144.Vayu, Nov. 1990. p.6.

145.Ibid.

146.Interview with Dr. Kota Harinarayana, Director, Air Defence Establishment Bangalore, 20 June 90.

147.Ibid.

148.USIS Press Release, 9 Oct 1987.

149.Ibid.

150.Science (Washington D.C.,) vol. 237, no. 15558, 25 Sept. 1987.

established supercomputer centres around the US where scientists can share its use.[151] Since they have revolutionized information processing and accurate weather forecasting, it would be a great boon to Indian agriculture giving timely warnings of cyclones, floods and typhoons and saving millions in property, life and human suffering.[152]

The Cray XMP-14, manufactured by Cray Research Inc., Minnesota, is a single processor supercomputer with a four million word memory and a speed of 110 million computations a second. It involves parallelism and some form of vector processing or multiprocessing architecture, 1000 times faster than a normal computer.[153] In March 1987, the National Aeronautics and Space Administration (NASA) dedicated a supercomputer built around a Cray-2 capable of 250 million calculations per second and a top speed of 1.72 billion computations a second with enough memory to hold and equivalent of 256 million words.[154] It simulated an extremely complex phenomena of flight, weather and galactic evaluation intended largely for aerospace research and design. The US transferred the Cray XMP-14 to India on its assurance that its assurance that it would be used only for civilian purposes. US wariness is because these supercomputers can be used both for industrial and military purposes.[155]

Some of the major landmark breakthroughs, mentioned above, seem to be due to the 1988 Science-Technology Initiative (STI) of Prime Minister Rajiv Gandhi and President Reagan between India and the US.[156] This was to initiate a fast track, high caliber, equal

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151. Ann K. Finkbeiner, "Doing the Impossible", SPAN (New Delhi), August 1988, p.5

152. Arvind Kala, "A copy of India", in Ibid., p.9.

153. Afzal Khan Worldnet, USA, 4 Oct. 1988, p.1.

154. Hearing Before the Subcommittee on Science, Research and Technology. U.S. Super Computer Industry. 101st congress. 20 June 1989, No.45 p.5.

155. L. Kelley, "US Supercomputer Sales Expand as International Markets Grow", Business America (New York), 11, April 1988, p.3.

156. USIS Press Release (New Delhi), 5 Oct. 1988.

partnership relationship, potential competitors in the world economy.[157] The US State Department, Congress and the public seemed to be enamoured of Rajiv Gandhi and the warmth between President Reagan and him was palpable.[158] Thus Indo-US economic, political and military exchange seemed to expand and a wondrous $49 million high-tech sales to India was given the US approval. This was followed by major events such as a $10 million US grant announced by Ambassador John Hubbard (1989) for technology development, to support the growth of commercial applications of technology.[159]

This is not to say that nothing positive happened before Rajiv Gandhi's visit to the US in June 1985 but not on the same level or in the same spirit with which it started happening after Rajiv Gandhi's visit. What actually happened was that India became a major US technological importer making it the sixth largest importer of US technology[160] It is also clear that the US objective in this regard is primarily mutually beneficial international cooperation and encompasses four primary objectives:[161] (i) to strengthen both nations' scientific and technological enterprise; (2) to promote foreign policy objectives and to improve US international relations; (3) to enhance commercial relations and establish new trading partnerships; and (4) to protect, and where possible, enhance US national security.

As liberal as the US transfer of technology may seem, it would appear a minor blandishment in comparison with American military aid to Pakistan and even the growing Sino-American technological cooperation, at least till the Tiananmen Square massacre in

157. Hindustan Times (New Delhi), 6 October 1988.

158. The Washington Post, 15 Oct. 1985.

159. USIS Press Release (New Delhi), 21 Aug. 1989.

160. Times of India (New Delhi), 25 Jan. 1988.

161. William R. Graham, Science Adviser to the US President's Remarks in "Key Themes in International Science and Tech. Policy", The US Perspective, (N.Delhi), Oct. 1988).

1989. Whereas in the case of Pakistan, assistance took the form of military end items, the American agreement with China placed India's other traditional adversary on an "extremely favourable footing, especially compared with the Warsaw Pact countries, for receiving high technology exports from the West and Japan".[162] The agreement with China was reached after US Defence Department officials had travelled to the major COCOM capitals and laboured through five weeks of negotiations in Paris to determine the nature and level of technology transfer that might be considered desirable. The sales agreement designated 27 categories of technologies, including computers and microelectronics, thus equating Communist China with other friendly non-allied countries.[163] This was a good example of diplomacy and circumvention of the COCOM by China.

Inspite of the positive high-tech transfers, the US has always remained reluctant to transfer such items as might contribute directly to India's weapon capability. So much so that the US was not willing to consider India's request for technological assistance for its booster rocket programme since it would contribute to missile delivery capability.[164] Thus, technology for the peaceful programme that involved rocket motors, inertial guidance systems, liquid fuel tanks and components, and propellant technology was excluded. This arose from the already prevalent fears that the next arms race in South Asia might be in the area of missiles.[165] So much so that the launching of the intermediate-range Agni missile by India in 1989 aroused ire amongst American policy-makers, as it was considered a defiance of the America-sponsored Missile Technology Control Regime (MTCR).[166]

162.Ibid., n.132

163.Ibid., n.105, p.843.

164.Interview with George W. Colin Jr., Space and Missile Policy Advisor, Office of weapons Proliferation Policy, Department of State, Washington D.C., 13 October 1992.

165.Interview with Ms. Juliette Swiecicki, Foreign Affairs Specialist, Arms Control and Disarmament Agency, Department of State, Washington D.C., 13 October 1992

166.Interview with Mr. John Konfala, Department of Defence, Washington D.C., 12 October 1992.

However, on satellites, there have been no US objections on technology transfers, but for initial apposition to India's requests for radiation hardened integrated circuits.[167]

There were fears that the implementation of the Super 301 clause[168] would also lead to the termination of US technological transfers to India, negating the goodwill of the 1984 MOU. But with the US decision to remove India from the trade sanctions list in June 1990,[169] the positive trend in Indo-US economic and technological cooperation will continue into the 1990s despite ups and downs.

Further, the recent Indo-US defence cooperation, suggested by the US under the 'Kick-leighter proposals', make Indo-US relationship more symbiotic. These proposals highlight exchange of officers, witnessing each other's military exercises and seminars dealing with strategic and operational matters.[170]

This is not to assume that there are no major differences between India and US. India's refusal to sign the Non-Proliferation Treaty continues to be an irritant to the US. Similarly US perceptions of it global states and strategies, as outlined in the Pentagon Paper, adversely affect India's attitude towards the USA.[171] The Pentagon Paper suggests that the US should discourage "Indian hegemonic aspirations over other states in South Asia and on the Indian Ocean".[172] With regard to Pakistan the perspective is that a US-Pakistani military relationship will be an important element in the strategy to promote conditions of a stable

167.Interview with Mr. Robert D. Shuey, Specialist in U.S. Foreign Policy, Library of Congress, Washington D.C., 5 October 1992.

168.Economic News (New Delhi), Sept. 1989

169.Economic News (New Delhi), July 1990

170.Times of India (New Delhi), 18 Sept. 1991.

171.Interview with Ms Claire K Oxley, country officer India and Bhutan, Department of State, Washington D.C., 14 October 1992.

172.Ibid, n.167.

security system in South-West Asia and Central Asia. But officials in both the US State Department and the National Security Council, with whom the Indian foreign secretary raised India's concerns, informed him that the Pentagon paper did not reflect the position of the US on various issues dealt with and that it is subject to further review.[173]

With regard to India's position on Special 301, investigations against India on the issue of Intellectual Property Rights (IPR) had earlier been terminated. The US trade Representative, Carla Hills, had, however, announced on 12 February 1992, that an inter-agency committee would be mandated to develop options for possible implementation and action if facts so warranted.[174] The issue would hopefully be further narrowed down when trade related IPR issues would be negotiated.

Conclusion

Having examined various aspects in depth and detail of the US policy on Technology transfer to the third world, particularly India, certain reflective conclusions seem to be necessary. US hegemony in economic, scientific, technological and security fields which remained unchallenged until the end of the 1960s in-as-much as that in the mid-1960s, vigorous debate began in Europe as to how to respond to the "American Challenge". It is precisely under this title that Jean Jacques Servan-Schrieber brought out his Best Seller in 1967 urging forcefully for deepening of European integration so that Europe could escape downgrading itself into a US satellite. However, it is since the early 1970s that the US perceived new challenges emerging from Europe and Japan to its leadership in the industrial domain. Gradually, new centres of industrial power made appearance both in the East and the West,

173. Ibid.
174. Ibid.

and as a result, the unicentric industrial hegemony of the US came to an end. Now, the US counts itself only as one among the three pillars of the global industrial order.

While the United States, as one of the constituents of the global industrial triad has to keep itself in a state of continuous contest with the other industrial competitors, and with this objective in mind, it has to ensure uninterrupted technology innovation and marketing. However, with the disappearance of the USSR, the US alone is at the apex of the unipolar structure of global order. The fact that it has to play a dual role in the global industrial and political selling, its motivation underlying transfer of technology has to be of interdisciplinary nature.

It may however be conceded that technology transfer from the US and or other developed industrial giants to the developing countries stimulates processes of industrial modernization, and to that extent it serves the purpose of the recipient, provided however that the latter receives appropriate technology with assured subsequent uninterrupted supply of necessary spare parts and equipments by the donor, and has the necessary wherewithal to ensure its efficient and appropriate use. It is equally understandable that technology transfer more often than not is creative of areas of technology dependence, which in the American jargon may also mean interdependence. Furthermore, since high technology is of dual-use, civilian and military, the US keeps under vigil the technologies being used in different developing countries in different critical areas of economic development, and also of turning them in times of crises situations to strategic use. Therefore, if the past experience is any guide, the US may apply brakes on technology transfer in critical areas if its economic and or strategic perspectives are in any way threatened as it happened in the case of supply of low enriched uranium for India's Tarapore plant in 1982.

Bearing in mind the conceptual frame of the US policy on technology transfer, such as it is, we may by now have a clear perception of how and with what effect the technology transactions take place between the US and India. Stated in simple terms, India for the most part, receives technology from the US either in the form of foreign direct investment or through inter-firm licensing.

One crucial decisive factor in technology transfer is its pricing. It is generally known that price incurred in technology transfer is complicated and varies in different situations. It is exceedingly difficult to quantify it, more so in the case of American technology, for here actual operations of technology supply are managed by their private firms and multinationals.

US bilateral economic assistance to India in 1980 was $246.4 million and in 1989 it was $126.2 million. Recently, allocated aid was reduced to a mere $4.1 million by the anti-India lobby as development assistance for 1994. This was linked to human rights issue in India, in Jammu & Kashmir and Punjab. Since aid has been and still is such a sensitive political issue, there is the need to review it especially in the science and technology sectors.

Without doubt, trade is politically loaded. The US continues to be India's largest trading partner and the most important source of foreign investment, joint ventures and of individual collaborations connoting technology transfer. The total value of bilateral trade after being around $4 billion from 1983-88, increased sharply in 1988. In 1988, the US accepted 25 per cent of India's exports and supplied 10 per cent of its imports. Indo-US trade has steadily increased. In 1988, it was over five and a half billion dollars with a $669 million trade surplus in India's favour. The trade surplus has been in India's favour since 1983. But then trade with the US is of a mere economical transaction, behind it there may be global strategic security concerns. In his recent speech, the present US president Bill Clinton emphasized upon the need to strengthen the US role in the global economy. He also subjected trade and aid to human rights, non proliferation and creation of free markets. But then he was equally forthright in saying that prosperity of America is linked with prosperity of the world.

Evidently, the US global strategic security interest diverge from those of India. Therefore the US transfer of high technology to India is affected noticeably.

Yet, surprisingly enough, India is presently the sixth largest importer of US technology and seems to have overtaken several NATO member states in this regard. Particularly, since the Memorandum of Understanding for technology transfer in November 1984, the volume and value of the US high-tech merchandise licensed for export to India has increased five-fold. Indo-US joint ventures in 1988 had also increased to 120.

High technology makes a contribution to the current state of the art. For the US, its control over high-tech exports to India means a tangible weapon of foreign policy. And, since high-tech includes both defence and civilian technology, the U.S. has been wary of transferring technology to this country. Since the late 1980s U.S. Department of Defence has funded only one-sixth of the R and D in the West as compared to one-third earlier. In the early 1990s, there has been a notable decline in the allocation of funds to the defence industry. This, ironically, could very well point to higher increase in transferring technology to India in a bid to make its own high technology cost effective and broad based.

One of the main controlling mechanisms over transfer of high technology in defence has been the COCOM export control, invariably used by the U.S. in pursuit of its foreign policy objectives. The COCOM duel list on transferring technologies has, until recently, been a major obstacle in so far as India is concerned. Furthermore, two major obstacles to the U.S. technology transfer are patents and intellectual property rights. These are directly related to the U.S. innovation and R&D.

India has been on the U.S. 'watch list' for quite sometime for intellectual property rights transfers. But recently the U.S. became somewhat accommodative and agreed to India reflecting on its property rights. Probably, the U.S. will continue to monitor the Indian situation under Special 301.

It is then noteworthy that despite the afore-cited obstacles, the US high-tech exports reached $537 million in 1987, up 17 per cent from 1986, In 1988, the U.S. licensed approvals for export of electronics, computers and telecommunications equipment to India increased sharply. Some 2970 license applications valued at more than $703 licenses valued at %22.7 million in 1983.

After the Indo-US Science and Technology Initiatives in 1988, there has been far more cordial dialogue and communication between the two nations. The recent Indo-US dialogue orientation and openness may promote foreign policy objectives and improve relations, thereby enhancing high-tech transfers.

India's liberalization policies may help smoothen the impediments hitherto affecting the relations between the two countries. The U.S. may have to reconsider its development strategies and relax its export restrictions in order to make high-tech transfers worthwhile and foreign policy more dynamic.

Chapter III

Germany's Perspectives on Transfer of Technology to India

Germany is one of the top ranking industrial powers with worldwide political and economic ties. Its progress depends on a stable and functioning world economic system and, hence, it is directly affected by developments anywhere in the world. Due to its geopolitical and economic interests, as also its experiences in the recent past, Germany has pursued a policy of peace.[1]

In the international system Germany is part of the free democracies. The basis of the Germany's foreign policy is its membership of the European Community and the North Atlantic Alliance. German foreign policy has four fundamental objectives: continuation of the work of European unification, maintenance and strengthening of the North Atlantic Alliance, further development of the policy of detente with the East European nations, and consolidation of cooperation with Third World Countries.[2] Its policy towards the Third World is based on cooperation and friendly relations, the awareness of its responsibility in global economic issues. Germany's main foreign policy aim is to maintain a peaceful world order.[3]

Indo-German Relations

The Federal Republic of Germany came into existence in May, 1949 when its

1. Facts about Germany. The Federal Republic of Germany. Bertelsmann. Lexicon Verlay. 1988 p.133.
2. Pfetsch, West Germany: Internal Structures and External Structures (New York: Praegar. 1988) p.3
3. Heinz Bongartz, "Unified Germany's Role After The Cold War". Paper presented at School of International Studies. JNU. 2 April 1993. p.4

constitution, known as the Basic Law, took effect. On 1 January 1951, India became the first country to formally put an end to the state of war with Germany. In the same year, the two governments agreed to exchange ambassadors.[4] Eventually, the FRG and the young Republic of India concluded a trade agreement in 1953 which became the basis of commercial exchange between the two countries. The tenor was set by Pandit Jawaharlal Nehru and Dr Radhakrishnan. Indo-German relations are based on a historical tradition of mutual exchanges in philosophy, the arts and culture. They are marked by common political fundamental values, mutual political interests and wide ranging cooperation in the spheres of economy, development, science and technology as well as culture.[5] Germany's political dialogue with India compared with other developing countries, reached an extraordinary level of depth and intensity after the unification of Germany.[6] India considers Germany to be its most important and favoured partner in Europe and also a guarantor of an open European market for India. Europe is seen as an important factor in the multipolar world after the end of the East-West antagonism.

In the mid-eighties, India's relations with Western Europe, Japan and the USA received a new impetus and vigour, as a consequence of Prime Minister Rajiv Gandhi's economic liberalization of India and, later, the end of the Cold War. There were and are many common interests between Germany and India in the areas of safeguarding peace, East-West relations, North-South dialogue and a close multilat-

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4. "Germany and India", Tenth Indian Engineering Trade Fair, 14-21 Feb 1993, New Delhi, p.1.
5. Indo-German Political Relations, Backgrounder, German Embassy, (New Delhi) 3 Feb 1993, p.1.
6. Ibid.

eral dialogue in the United Nations, World Bank, FAO, GATT, International Finance Corporation and the Asian Development Bank. This has served to make cooperation between Germany and India easier India welcomed German unification. It was not one of the nations which were apprehensive of the aggressive assertiveness of a unified Germany.[7] To these factors were added a specific Indian interest in cooperation with Germany as well as an increasing German economic and political involvement with India.

Technogerma, the large exhibition of German progress, held in Delhi in 1988 heralded economic and technological tie-ups.[8] Prime Minister Rajiv Gandhi's visit in June 1988, introduced a phase of active diplomacy. In 1989, R Venkataraman became the first Indian President to visit the FRG. The state visit of the President of the Federal Republic of Germany followed in spring 1991. Federal Foreign Minister Hans-Dietrich Genscher represented Germany at the funeral of the late Rajiv Gandhi in May 1991. The Indian Ministers of External Affairs, IK Gujral and M Solanki, visited Germany in 1990 and 1991 respectively. In December 1991, Federal Minister Möllemann[9] visited Delhi accompanied by a large economic delegation. Besides the state visit by German President von Weizsäcker,to India,[10] Prime Minister PV Narasimha Rao's visit to Bonn in September, 1991, which coincided with the inauguration of the "Festival of India" in Germany, marked the climax of growing Indo-Germans relations. This was Prime Minister Rao's first foreign visit after as-

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7. Times of India, (New Delhi), 8, Oct 1991

8. Technogerma India' 88, Seminar Report on Recent Socio-Technological Development in India and Germany (New Delhi: Max Muellar Bhavan, 1988)

9. Report of the Evaluation Committee for Indo-German Cooperation in Science and Technology, 28 Febuary 1991, p.3.

10. Times of India, 28 Feb 1991.

suming office.[11] These diplomatic visits emphasize the close cooperation between Germany and India and constitute an instrument to project common interests, motives and goals. They enhance cultural, economic, political, scientific and technological exchanges between the two countries. During his visit Prime Minister Rao was able to convince German leaders and industrialists of the Indian Government's economic reforms package. He underscored its irreversible character, in his talks with Dr Helmut Kohl and Dr Möellemann and expressed a desire to foster integration with the global economy.[12]

Prime Minister Rao's visit to Germany has helped create a climate conducive to the flow of more investment and high technology to India, though as expected, it has not yielded any substantial immediate gains.[13]

This is understandable as Chancellor Helmut Kohl had made it clear that united Germany had its own economic priorities, including support to reforms in central, eastern and south–eastern Europe, further development of the European Community and the consolidation of Germany's "inner unity". As such, it had its economicconstraints. He, however, affirmed that "despite this burden, we will remain committed to our development cooperation with India".[14] German industry and trade however, responded positively but had misgivings about the effective and speedy implementation of well-intentioned reforms in view of the Indian bureaucratic red tape.

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11. Times of India, 10 Sept 1991
12. Ibid.
13. Times of India, 14 Sept 1991
14. Times of India, 14 Sept. 1991

Prior to this itself, India and Germany had evolved a joint action plan to expand bilateral trade and industrial ties. The German side had proposed that India liberalize its foreign investment and trade policy and evolve methods for technology transfer between Indian and German companies without having to wait for government approval.[15] These proposals were made at a meeting of German and Indian industrialists organized by the Confederation of Engineering Industries (CEI). The meeting was co-chaired by Dr Heinrich Weiss, President of the Federation of German Industries (BDI) and Mr Srinivasan, President of CEI.[16] Dr Weiss also proposed cooperation between the two countries on the Uruguay Round, review of the intellectual property rights policy of India, support to India in the EEC after 1992, working for volume-based expansion of bitateral trade and Indian investment in Germany.[17]

The parliamentary contacts already established enhanced the spectrum of Indo-German dialogue in 1992. A consultative group to further Indo-German ties was mooted[18] which met on 16 Sept 1992.[19] It was topped by the Nehru Award for International Understanding which was given to the Federal Chancellor Helmut Kohl for the role played by him in the peaceful unification of Germany and "Union of Europe".[20]

Indo-German Development Cooperation

The FRG attaches great importance to development cooperation with the countries

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15. Times of India, 4 March 1991
16. Ibid.
17. Ibid.
18. The Hindu, (Madras) 2 March 1991
19. Ibid., n.5., p.2
20. Times of India, 19 Feb 1993

of the Third World. This is confirmed by the scope of development assistance. The FRG is one of the world's foremost donors of development assistance, working together with 130 states worldwide on an equal partnership basis.

Aid

In 1986, official development assistance provided by the FRG amounted to DM 8.31 billion, or 0.43 per cent of its gross national product. The average among the Western industrialized countries is about 0.36 percent.[21] More than half of German aid is granted to poor countries with a per capita income of less than US $400 per year. Comparable aid statistics, overall of the OECD nations, the US and FRG aid to India are presented in Chap I. Suffice to say that development cooperation programmes are adjusted to fit the economic framework and political conditions of the aid-receiving countries. The main recipient of German development assistance is Africa (44%) followed by Asia (37%) and Latin America (13%)[22]

Table I

German Financial Assistance to India 1980-1990:

Yearwise Commitments on the basis of the All India Consortium[23]

(DM million)

	Total	Project Aid
1990-91	457	364
1989-90	518	353

21. Press and Information office of the Federal Government Public Document No 8. (Bonn). Oct. 1987. p.1
22. Ibid.
23. Indo-German Chamber of Commerce. Annual Report Indo-German Cooperation. 1990. (Bombay. 1990).

1988-89	448	183
1987-88	395	215
1986-87	395	230
1985-86	360	210
1984-85	360	210
1983-84	337	196.5*
1982-83	360	225
1981-82	360	195
1980-81	360	178

* including Nabard

Conditions of Financial Aid

In principle, the financial cooperation funds are made available to India in the form of loans which have a repayment period of 40 years, including a grace period of 10 years. The rate of interest is 0.75%.[24] Though India continues to be the main recipient of German aid in asia , the earliest inflow of which dates back to 1958 when the Rourkela Iron and Steel Works were set up, the pioneer aid givers to India were the USA, Canada and Australia. In 1951, they initiated the inflow of foreign aid to India.[25] The above can be compared with external assistance to India—gross and net. Table II reveals that external assistance to India has been on the increase.

24. Ibid., p. 47.
25. Ibid.

Table II

External assistance to India

(Rs. million)

Year	Gross Disbursements (Utilization)	Debt Service	Net flow of Assistance
1980-81	21617	8039	13578
1981-82	18884	8491	10393
1982-83	22498	9475	13023
1983-84	22676	10325	12351
1984-85	23537	11762	11775
1985-86	29381	13666	15715
1986-87	35959	20291	15668
1987-88	50320	29470	23450
1988-89	52914	26230	24090

Source: Indo-German Chamber of Commerce, ibid., n.23.

Motives for Assistance

The FRG's economic and social development and to the Third World is of decisive significance to political stability and peace in the world. The Federal Chancellor Helmut Kohl emphasized in his policy statement of March 1987, that the future world would be able to live in peace, freedom and stability, if hunger and need could be alleviated, the prosperity gap between North and South narrowed and, wherever possible, respect for human rights enforced.[26] However, there is a practical com-

26. Press and Information Office of FRG, FRG Economic Cooperation. (Bonn), October 1987.

pulsion for the FRG to grant development assistance. The FRG is dependent on exports. It is, therefore, in its own interest as well, to attach importance to economic recovery and progress in the developing countries.[27] The more productive the economy of a developing country, the more attractive a partner it is for German trade and investment. Therefore, FRG's development policy links aid, trade and investments (transfer of technology). German development assistance policy emphasizes the following points:[28] (1) Concentration on the poorest and satisfaction of basic needs; (2) attainment of self-sufficiency in food; (3) more latitude for self-help measures; (4) greater consideration for the role of women in the development process; (5) education and training; (6) environmental protection; (7) support to structural adjustment measures, i.e., political and economic framework conditions that ensure that foreign assistance is effective, in setting development in motion.

With German bilateral aid commitment of more than India continues to head the list of Germany's partners in asia development cooperation.[29] In 1992, the volume of commitment of the German Government for bilateral development cooperation with India adds up to DM 555 million (about Rupees 1,100 crore) which includes: (a) an agreement on bilateral financial cooperation (signed on 12 Oct 1992 in New Delhi), consisting mainly of soft loans, grants of DM 55.7 million (Rupees 112 crore) and (b) technical cooperation involving grants of DM 40 million (Rupees 80 crore) to reduce poverty.[30] Added to this was a financial credit of DM 75 million (Rupees 129 crore) from the state-owned Development Loan Corporation

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27. Ibid.
28. Ibid.
29. Backgrounder German Embassy. (New Delhi) 3 Feb 1993. p.1
30. Ibid.

(KFW Bank) at near-market rates (for a gas saving revamping power plant in Maharashtra).[31] Also 70 million DM (Rupees 120 crore) were given as grants from the Federal German Government and German State Governments for scholarships and training of Indian experts in Germany, as well as for encouraging the efforts and adding to the donations of German voluntary organizations that support development activities in India.[32] The disbursements of Indo-German financial cooperation have also increased substantially in 1991, reaching an all-time record of 426 million DM (Rupees 750 crore); in 1992, it was 392 million DM (Rupees 700 crore).[33] The main reason for this is that the German Government is quick to recognize the Indian economic reform programme and wants to support it. Other German projects, designed to contribute on a somewhat sustainable basis, to, and reach a better social and regional balance of development, are in watershed development, basic education, sanitation, forestry, integrated rural development and the like.

German aid to India has not been free of controversy. The Federal Ministry for Economic Cooperation (BMZ) wanted to reduce its aid to India from 1992. Mr Spranger, the BMZ minister, planned to reduce aid on the grounds that India had a high defence budget, raised by four per cent. This move was not fully supported by the ministries of economics, foreign affairs and finance[34] and it was put forward that India had reduced its spending on arms, in real terms by more than 10 per cent.[35] India and Germany did sign an aid pact in which 56 per cent of the

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31. Times of India, 6 Sept. 1991
32. Op. cit. p.2
33. Times of India, 1 March, 1991
34. Times of India, 5 August 1991
35. Ibid.

assistance was in the fast-disbursing category. That Germany would give bilateral aid of 350 million DM to India in 1991 was agreed to between Mr Muchkund Dubey, the then Indian's Foreign Secretary and two senior German officials, Mr Kastrud, the State Secretary for Foreign Affairs and Mrs Geiger, the Parliamentary State Secretary in the Economic Cooperation Ministry.[36] The bottom line, though, in resolving this controversy was Chancellor Kohl's understanding that India's economic reforms were genuine as was its motivation to integrate into the world economy. The Chancellor underlined the importance attached by Germany to India, ''a major partner which is actively shaping its political and economic future, and which is also shouldering the regional and international responsibilities devolving on it''.[37]

The political economic interface is an important and intrinsic one. The two are very much intertwined, as is seen further by Mr. Kohl's statement that Germany wanted to be shaped by cooperation and peaceful reconciliation of conflicting interests rather than dispute and violence. German unity, European union, maintaining peace and fostering development are Germany's priorities.[38] It is in this context that one finds that Indo-German relations have gathered considerable momentum in recent years. Development in Indo-German trade, investment and transfer of technology is promising.

Trade

Over the past 20 years, Indo-German trade has increase from a total of less than DM one million in 1969 to more than five billion DM in 1989.[39] Indian ex-

36. Times of India. 7 September 1991
37. Ibid.
38. Ibid.
39. IGCC Annual Report. Indo-German Cooperation 1990 (Bombay. 1990.) p.9

ports to Germany during this period have expanded by 865.5 per cent and imports have risen by 510.5 per cent.[40] The Indian export palette has changed in the sense that raw materials, which made 21 per cent of the exports in 1969, have dropped to just about 4.48 per cent.[41] Import trade, though, has consistently been dominated by finished products which comprise mainly machinery and electrical equipment. Table III provides details of Indo-German Trade.

Table III

India's Exports to Germany, 1969 and 1989.[42]

	1969	1989	1969	1989
	DM Million		%age share	
Total	236.96	2888.0	100.0	100.0
Thereof:				
Primary Products	100.76	799.10	42.5	34.0
Raw Materials	51.72	102.53	21.8	4.4
Finished Products	24.77	1130.68	10.4	49.4
Semi-finished Products	17.08	94.57	7.2	4.1
Beverages and Tobacco	28.50	18.79	12.0	3.5
Vegetables and Foodstuffs	11.82	71.92	5.3	3.1

40. Ibid.

41. Ibid.

42. Ibid.

India's Imports from Germany 1969 and 1989.[43]

	1969	1989	1969	1989
	DM Million			%age share
Total	498.45	3043.3	100.0	100.0
Thereof:				
Finished Products	320.51	1827.87	64.3	60.0
Primary Products	135.35	839.85	27.1	27.5
Semi-finished Products	21.16	303.88	4.2	9.9
Vegetables and Foodstuffs	12.27	13.26	2.4	0.4
Raw materials	4.22	28.05	0.8	0.9

To get a more realistic picture of Indo-German trade one has to see it in the context of total German foreign trade to get a comprehensive picture. In 1989, worldwide German imports increased by 15 per cent as against a 25.73 per cent increase in imports from India.[44] But, while German exports to the rest of the world improved by 13 per cent over, exports to India increased only marginally (+3.7%).[45] Amongst Germany's major suppliers and buyers in the world, India ranks 34 and 31 respectively.[46] In 1989, the share of Indo-German trade in Germany's total trade was 0.5 per cent.[47]

43. Ibid.
44. Ibid., p.12.
45. Ibid.
46. Ibid., p. 13
47. Ibid.

Table IV

Germany's Principle Trading Partners[48]

(DM Billion)

Total Trade	1,147
France	144
Netherlands	106
Italy	104
Great Britain	93
USA	84
Japan	47
China	10
India	5

In terms of bath export and the import, Japan is the leading partner, accounting for 43.89 per cent of Germany's trade with East Asian countries. India was seventh in 1989. Within the EEC, Germany is India's largest partner. Almost 30 per cent of the total Indo-EEC trade was with Germany alone. Around 27.94 per cent was Indo-British trade and Belgium was the third largest partner with 22.91 per cent.[49] Indo-EEC trade has been expanding at a fast pace during the last few years. While part of the increase is accounted for by the expanding membership of the EEC to a total of 12 nations at present, the development of India's trade jumped 24 per cent in 1988-89 reaching Rs. 127 billion.[50]

48. Ibid.
49. Ibid., p.14.
50. Ibid., p.15.

Table V gives a fair idea of the increase in India's trade with the EC in the late 1980s.[51]

Table V

India's Trade with EC

		1988/89	1987/88
		Rs. million	Rs. million
EC	Imports	90215	74002
	Exports	37362	29076
Germany	Imports	12366	10619
	Exports	24719	21586

As a general principal, import of goods into the FRG are free from restrictions. Permits are required only in exceptional cases. A distinction has to be made between liberalized imports and imports subject to quota. While imports of industrial products have almost been completely liberalized, there are restrictions for import of textile fibres and products.[52] On 3 March 1991, India and Germany evolved a joint action plan to expand bilateral trade. Germans proposed that India liberalize its foreign investment and trade policy and do away with government approval for technology transfer between Indian and German companies.[53] Also, as discussed earlier, increased bilateral trade and investment was planned. In fact in 1991, for the first time in the history of Indo-German trade, India had a trade surplus. The surplus was DM 159 billion (Rs. 2.25 billions) during January to March 1991, while

51. Ibid., p.14.
52. Ibid., p. 15.
53. Times of India, 4 March 1991

during 1990, India had a trade deficit of Rs. 1.4 billion.[54] According to an official press release, India's exports to Germany surged ahead 16 per cent between January and March 1991, compared to the first three months of 1990, while imports from Germany declined 18 per cent.[55]

Collaboration and Investment

Germany has continued to be India's second largest partner in industrial collaboration. The Indian Government approved 112 new proposals for Germany during 1989. Of these, 38 were joint ventures with German firms. However, these figures represent a sharp decline as compared to sanctioned during 1988 (178 approvals of which 47 were with financial participation).[56] Nevertheless, the Indo-German collaboration figures are indicative of a general downward trend in foreign collaborations sanctioned by the Indian Government during 1989.[57] At 605, the total number of approvals for foreign collaboration was down 35 per cent over 1988, when per cent 926 approvals. The number of joint ventures was also correspondingly lower at 194 as against 282 in 1988. The number of joint ventures was also correspondingly lower at 194 as against 282 in 1988, a 31per cent drop.[58] All collaborators experienced a cut back in sanctions as well sanctions for the US dropped from 191 in 1988 to 127 in 1989, for UK from 134 to 66 and for Japan from 96 to 62.[59]

Table VI[60] gives India's overall foreign collaborations. It shows USA topping

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54. Times of India, 27 July 1991
55. Ibid..
56. Ibid n.39., p.23.
57. Ibid.
58. Ibid.
59. Ibid.
60. Ibid, p.26

TABLE VI

INDO-FOREIGN COLLABORATIONS SANCTIONED ANNUALLY 1957/1989

Country	1957/ 1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Total
U.S.A	484	36	18	33	43	62	48	79	55	69	54	59	48	125	85	110	135	148	197	189	197	191	127	2592
UK	757	19	34	39	55	38	53	59	54	54	59	61	63	110	79	107	119	126	147	130	122	134	66	2485
Federal Republic of Germany	413	22	28	36	42	49	60	71	59	60	55	58	55	100	74	110	129	135	180	183	147	178	112	2358
Japan	237	12	17	15	35	27	38	28	23	10	20	28	12	34	27	51	58	78	108	111	71	96	62	1198
Switzerland	126	6	7	13	14	15	10	33	27	22	23	18	14	38	26	41	47	30	42	32	31	41	22	678
France	113	8	7	7	15	14	13	22	13	17	14	21	17	24	23	28	40	38	61	39	44	42	23	633
Italy	75	3	3	8	5	8	5	16	10	8	10	13	16	25	18	37	30	38	56	58	50	53	37	582
Sweden	44	4	2	3	3	4	7	11	4	6	4	8	5	10	11	15	15	14	29	29	19	11	17	275
Netherlands	42	2	3	3	4	4	2	3	1	6	4	10	6	8	9	14	13	14	16	26	23	15	12	240
GDR	60	2	5	5	5	3	4	2	3	7	3	8	6	4	4	2	10	11	12	6	3	5	3	173
Denmark	29	4	2	1	2	1	3	4	-	4	3	2	3	6	1	4	3	6	12	7	11	11	7	126
Austria	25	-	-	3	1	1	2	1	-	4	2	2	2	5	8	8	3	8	14	16	9	6	7	124
Canada	19	-	2	-	1	1	2	3	6	1	2	3	2	-	2	1	6	8	15	15	9	10	6	114
Czechoslovakia	28	4	1	5	5	6	5	5	3	1	1	1	2	4	-	5	2	1	7	4	5	4	5	104
Belgium	24	1	-	1	3	3	1	5	5	1	2	-	3	2	1	4	8	5	9	6	7	6	9	106
Hungary	13	1	1	1	1	3	1	2	1	2	3	1	1	2	3	3	2	6	2	2	3	3	3	60
Finland	4	-	1	1	-	-	-	3	1	-	2	1	3	5	2	4	1	2	4	5	2	10	5	56
Poland	18	-	-	-	-	-	1	-	-	2	1	1	1	2	4	4	1	1	2	2	1	-	4	44
Yugoslavia	12	2	-	-	-	1	1	-	1	-	-	-	-	3	1	2	-	-	6	-	3	1	-	33
Others	229	5	4	9	11	17	9	12	5	7	5	12	8	19	11	41	51	83	105	98	94	109	78	1022
Total	2742	131	135	183	245	257	265	359	271	281	267	307	267	526	389	591	673	752	1024	958	853	926	605	13007

the list, followed by Germany and UK Indo-German collaborations numbered 2,358 at the end of 1989. The number of agreements in operation is 744.

With Rs. 1,200 million sanctioned investments, Germany topped the list of foreign investors in India for the first time. German investment proposals, in fact, accounted for 38 per cent of all foreign investments sanctioned by the Indian Government in 1989.[61] This was followed by USA (Rs. 622 million); UK (Rs. 330 million) and Japan (Rs. 88 million).[62] German private investment in India amounted to a total of DM 368 million, including reinvestment (as of December 1989), showing an increase of 7.6 per cent over 1988.[63] Around 31 per cent of all German investment in India is in the chemicals sector; electro technology has 16 per cent and machinery, 30 per cent.[64] Table VII provides data about private investment of Germany and India.[65]

Table VII

German Private Investment in India

Up to	DM Million	% change
1980	205	+20.6
1981	244	+19.0
1982	281	+15.2
1983	320	+13.9
1984	358	+11.9

61. Ibid.
62. Ibid., p.25.
63. Ibid.
64. Ibid.
65. Table I, ibid., p.28.

1985	355	-00.8
1986	340	-4.2
1987	342	+1.5
1988	368	+7.6

It collaborations and investments, including joint ventures, are legitimate modes of technology transfer, the spurt in their increase after 1985 should indicates mutuality of interests in policy making. Hence there is no rational explanation for a decline in the number of collaborations in 1987 and 1989.[66] In fact, since July 1988, an informal group called "Fast Track"[67] has been meeting every month under the chairmanship of a Joint Secretary in the Union Ministry of Finance to solve problems faced by German firms in business with India, as well as to promote German collaborations and investments. These meetings are attended by representatives of the two governments and the Indo-German Chamber of Commerce. The Industrial Policy Statement of the Government of India, 1991, was also designed to encourage technology transfer. It provided for approval for direct foreign investment upto 51 per cent equity in advanced technology industries.[68] The Government of India has also decided to take steps to remove bottlenecks of every kind. FERA companies have been allowed to invest on a discretionary basis.[69]

Acquisition of technological capability is a priority with the Government of India. To ensure smooth and continuous relations between technological suppliers

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66. Refer Table VI.
67. Ibid., p. 28.
68. Ministry of Industry, Govt. of India, Statement on Industrial Policy, (New Delhi), 24 July 1991, p.9.
69. Ibid.

and users and to make Indian industry competitive, the Government of India has decided to give automatic approval for technology agreements related to high priority industries within specified parameters.[70] This is to ensure more investment in R&D, greater efforts to indigenize, and freedom to negotiate technology transfer agreements.[71] Industrial licensing, too, has been liberalized. It is to be abolished, except for a short list of industries related to strategic and security and concerns, social, hazardous chemicals and overriding environmental reasons.[72]

Automatic permission for foreign technology agreements in high priority industry upto a lumpsum payment of Rs. 1 crore, five per cent royalty for domestic sales and eight per cent for exports, subject to total payments of eight per cent of sales over a ten year period from the date of agreement or nine years from commencement of production are progressive measures.[73] However, a major draw back is that the priority industries and high technology transfers, with which we are dealing, are automatically reverted to the proposed list of industries to be reserved for the public sector.[74] Further, these same items such as electronics, aerospace, defence equipment, etc., are in the list of industries in respect of which industrial licensing will be compulsory.[75]

FRG's Research and Technology Policy

Heinz Riesenhuber, the then Minister for Research and Technology of FRG,

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70. Ibid., p. 11.
71. Ibid. Michel Andre, "Research and Technological Development Policy" (European. Documentation, Luxembourg), 2/1988, p.43
72. Op cit, p. 16.
73. Ibid., p. 18.
74. Ibid., Annex I, p. 21.
75. Ibid., Annex II, p.22.

identified six areas in which research and technology should increase for the further development of culture, human life, solution of current problems and the mastery of future tasks:[76]

1. Intellectual and cultural heritage.

2. Contributions to knowledge which make optimally consistent solutions to problems. This also includes technology assessment.

3. Innovation and technical progress, i.e., the steady expansion of the scope for human action by means of generation and economic application of new technological possibilities. Although not always without pain or friction, technical progress, facilitates the continuous structural adaptation of the economy to changed competitive situations, changed needs, and ever scarce resources. High technology products contribute to economic growth create and more jobs in the service sectors.

4. Social progress, where the positive effects of research and technology benefit man immediately. It means improvement of life's opportunities as a result of more leisure time and almost unlimited mobility.

5. Conservation of environment is a question of research, technical development and innovation. It also covers the energy question. FRG has spent a lot on R and D (Table VIII)[77] and it has resulted in inexpensive nuclear energy. Coal conversion and utilization of solar energy are also forese-able. The FRG Gov-

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76. Riesenhuber, "Orientation and Perspectives of the German Federal Government's Research and Technology Policy", International Journal of Technology Management, (Geneva) vol. 1, no. 3/4 1986, pp. 267-68.

77. Federal Ministry for Research and Technology Report, (Bonn,) 1988, p.62.

ernment, therefore, holds the view that research and technological progress are inseparably interwoven with ecological progress.

International Cooperation

Finally, the role FRG plays as a global partner in science, technology and in the world economy is crucial. This applies, according to Riesenhuber, to Western industrialized countries, and developing and newly industrializing countries, as well as to the Eastern/ bloc countries. Scientific efficiency and technological know-how are both the stimulants and the yardstick of international cooperation in technical and economic fields. FRG's political integration with the EC and the westernized industrial states is soundly established in the joint promotion of major scientific projects, scientific exchange and technological cooperation. Another goal of cooperation by FRG is to help developing countries solve their problems and in the long run to contribute to the peaceful coexistence of all. Population is going to increase to more than six billion by the year 2000. The growth mainly will be in the developing and newly industrializing nations. There will be increased problems of food and water, improper soil utilization and deforestation as a result of poverty and insufficient resources, further aggravating existing problems.

It is Riesenhuber's perception that assisting Third World countries in scientific development and technological potential, would help not only resolve these problems and show solidarity between FRG and developing countries, but also provide for FRG's own future and ecological concerns. Therefore, cooperation in science and technology could and would become an instrument for improving relations among nations. Science, research and technology as international link elements, and with far-reaching opportunities for cooperation, lead to economic competition, and then to common goals and common responsibilities.[78]

The synergism necessary for high technology innovations, of complementary knowledge from many different areas of knowledge, in addition to the traditional cooperation in basic research and in very long-term projects, such as nuclear fission, has led to internationalization and globalization of science and technological development, in which worldwide cooperation of companies and scientific institutions play an ever greater role.[79]

Increasingly, international cooperation in research is creating the basis for a method of production, based on an internationl division of labour, with greater emphasis also on the harmonization of technical norms, standards and approval of regulations. This internationalization has become an essential factor in the further worldwide integration of national economies, and to no small extent in FRG's case, in the development of a European internal market.[80]

Science, Technology and Research in Europe as Located in International Politics

The growing importance of technological progress for the international competitiveness of national economies has, in particular, meant that in the last 10 years, the issues of science, technology and research have moved into the centre of politics, including international politics.[81] The most important issues (in the European

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78. The Federal Ministry of Technology, Report of the Federal Government on Research, (Bonn,1988), p.10.

79. Ibid.

80. Ibid.

81. Ibid.

context) have been in this regard;[82]

1. The debate about Europe's future technological competitiveness, in comparison with the Pacific Basin and also its creativity and socio-economic vitality.

2. The consequent European initiatives to encourage cooperation in research and development in key civil technologies, in environmental technologies and in the further development of a Europe-wide scientific infrastructure, among other things, within the framework of EUREKA, and extending, as far as the declared political intention of the member states of the European Community is concerned, to create a European technological environment, which has now found its exp-ression in the Single European Act.

3. The resolution of the European countries, born likewise of the idea of further European integration and self assertion and of cooperation with the USA, to develop an independent capacity in space research and activities, including an element of manned space travel, and to participate in the planned international space station.

4. The debate, conducted in the USA in the light of Japan's technological and economic successes in micro-electronics and in the area of high technology in general, about securing the lead in science and technology and about free access to scientific capacities and results.

5. Raised in conjunction with the manifest globalization of technological development, questions relating to the adequate and effective protection of intel-

82. Ibid., p.11.

lectual property and the prevention of technological protectionism, are matters which have been discussed in various forums (OECD, Conference of Research Ministers, 1987).

6. The further increased awareness of the need for international cooperation in basic research, as demonstrated, for example, in the joint construction and operation by Western European countries of large-scale basic research projects or in the Japanese initiative for a worldwide "Human Frontier Science Programme".

7. Finally, China opening its doors to economic, scientific and technological cooperation, along with sweeping reforms in the USSR, has shown an inclination to innovate and cooperate with Western industrialized nations to close the widening technological gap between the East and West.

In the long run, an atmosphere of freedom, individual initiative, and democratic structures are indispensable for the success of modern science, technology and innovation. Creativity emanating from scientific and technological development does not stop at ideological frontiers. Further, the theme of joint responsibility for the protection of the Earth, in recent years, has become a leading topic in international politics.[83]

The European Technology Community

It is evident that the European Community has emerged from the static and non-productive seventies with its Europessimism and Eurosclerosis and moved dynamically toward the challenge of the further integration of the diverse national econo-

83. Ibid.

mies, through the formation of a single mass economy of scale.[84] Central to this Western European resurgence have been the active and determinant roles of the high-technology industry leadership and the EC Commission pressing for the creation of a globally competitive European technology community. Put succinctly, the major catalyst for the White Paper of 1985 and Single European Act (SEA) of 1986, that propelled the twelve to go to 1992, was the alliance of the European public and private elites promulgating the need to construct a centrepiece in telecommunications, electronics, aerospace and finally in advanced television High Definition TV for an accelerated future European market growth and true global competitiveness.[85] The EC, coalition has designed and produced a series of high-tech programmes, such as ESPRIT and EUREKA, that focussed on swift development in this critical sector of a collaborative multinational electronics research capability.[86] It further documents the emergence of two related strategies and policies which grew out of the research and technology development (R & D) programmes of 1979-86 and which, in tandem with the preceding programmes, resulted in a real revolution in the Western European political economy. First, there was the belief of the business that the propelling force to market revitalization and competition was more liberalization and deregulation of the economic market place. Second, their position in accord with the Commission, was that there had to be a link between the drive to a collaborative information technology (IT) and electronics technology development and the completion of a single European market, that is, a borderless

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84. Laurent, ''Forging the European Community'', in The Technical Challenges and Opportunities of a United Europe, ed., Michael Steinberg, (London: Pinter, 1990), p.59.

85. Ibid.

86. Kart Heinz Preuss, & Rolf H Simen eds. The Federal Republic of Germany: A Land of Top-Ranking Research, Bonn, Internationes, 1986. p.64

Europe.[87]

This rapid evolution of Eurotech—a Community research and technology policy, in the eighties—was the result of business and technocratic awareness, that the global third industrial revolution of the seventies necessitated a swift and massive economic transformation.[88] The maxim of cooperation, as a corollary of competition, served to forge a mega economy to make European trade competitive with the Japanese and the Americans.[89]

The actual basis of the political coalition that emerged in the late seventies came together just as a severe technology markets' revolution hit the Europeans. The technocratic experts of the Commission, employing Etienne Davignon, the Belgian Commissioner, as their power base, and the leading representatives of 40 high-tech industries realized that US and Japan were pulling far ahead in the global race for electronics sector markets.[90] To bridge this technological gap, revived European trade competitiveness meant not emphasizing a one-sector expansion and elaborate cross-frontier teamwork, but more integrally, moving the political economies to a supply-side initiative, liberalization and deregulation of markets.[91]

ESPRIT

The origins of European Stategic Programme in Information Technology, (ESPRIT), Basic Research in Industrial Technologies in Europe (BRITE), and Research

87. Carlo de Benedetti, "Europe's New Role in a Global Market" in Andrew J Pierre, ed., A High Technology Gap, (New York: Council on Foreign Relations, 1987.) p.73.
88. Op. cit.
89. Ibid. n. 83, p. 60.
90. Ibid.
91. The New York Times, 22 May 1988.

in Advanced Communications Technology in Europe (RACE), projected a consensual European economic order away from government and towards greater market freedom. This union of forces, with the heavy economic and political clout of the high-tech elite at its centre, developed the ideas of reorienting the basic economic outlooks for Western Europe and confronting the task of completing the European general market.[92] ESPRIT was launched in February 1984, and had three main goals: (1) to promote European industrial cooperation upstream wherever possible; (2) to allow European industrialists to avail of technologies that would be useful to them in reinforcing their positions in the next five to ten years; and (3) to establish a united European platform in preparation for movement toward international norms.[93] ESPRIT projects are financed half by EEC funds and half by the participants. The total budget for the first five years was 111.5 billion.[94] The programme has an international approach, i.e., each project has to draw together firms or research agencies from several countries. A special effort has been made to involve small and medium sized enterprises in the project.

ESPRIT spans such fields as microelectronics, software technology, the architecture of information processing system, and factory automation techniques. At work on this programme are 500 groups, of which half are industrial firms, a quarter are universities and another quarter are public research institutes.[95] The strategy of ESPRIT became acceptable because its initial successes reflected strong national govern-

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92. n. 83, p. 62.

93. Curien, Herbert, "The Revival of Europe", n.86, p.57.

94. Towards a European Strategic Programme for Research and Development in Information Technologies. Communication from the Commission to the Council, of the European Communities, Brussels May 1982.

95. op. cit.

ment approval and support.[96]

Due to more extensive synergism between ministries and cabinets, the Commission and the high-tech leaders became visible and influential in the formation of the Round Table of European industrialists, the Monnet Committee number 2 (composed of Euro-Parliamentarians), the Round Table of European bankers, the so-called 'Kangaroo Group' of European legislators and even the Schmidt-Giscard monetary group.[97] The Kangaroo Group and the Monnet Committee were the prime initiators in the EP (European Parliament) of what would become the Single European Act, to actually smooth Community decision-making through institutional changes in the voting procedures.[98] These lobby associations drove relentlessly to support the formation of a Europe-wide response to the economic malaise and the resulting political dilemmas. When two new groups representing European labour and consumers too joined this effort, the way was even clearer for a concept, such as EC-92.[99]

At numerous industrial meetings, considerations of the bleak technological future without cross-frontier collaboration began to compete with issues of transformation of the European political economy. In the first domain, the argument about Japanese and American technological domination, especially in mainframes and computers,

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96. Lynn Mytelka and Michael Delapierre, "The Alliance Strategies of European Firms in the Information Technology Industry and the Role of ESPRIT," Journal of Common Market Studies Geneva, vol.26, no. 2, 1987, pp. 231-53.

97. Pierre Lament, Henri, Renaissance Through Technology: The European Decision on ESPRIT, (Boston: The Fletcher Forum), Winter 1985, pp. 155-67.

98. Ibid., n. 83, p. 62.

99. Ibid.

was explained in part by acknowledging Europe's inherent disadvantages.[100] These include meagre venture capital, duplication or replication of basic research efforts and a disturbing disconnection between the 'idea-state' in research and the finished product at the market stage. Moreover, the segmented and separated talent pools divided Europe into isolated university and institute teams and the private sector laboratories.[101] Considering all these obstacles to efficiency and growth, there was little disagreement that the smallness of even the titan European technology, when compared to their world competitors, made the European firms incapable of sustained and successful competition.[102] As national economies divided Europe, it could not compete in its own markets, let alone others; the solution had to be industrial and technological cooperation and coordination which would transform Europe virtually into one large market. The basic decision of the 1982-84 period was to emphasize the internal priorities of consumer electronics, computers and integrated circuits in the grand design of Eurotech.[103] In this, the ESPRIT, RACE and BRITE programmes helped and furthered the aim. The prime example was harmonizing standards so that interchangeability and connectibility would result and make Europeans more competitive.[104] The actual programmes for uplifting European telecom, aerospace and computer technology in the new era of global competition were by 1984 a part of a broader and more comprehensive private sector plan to address the reform of the entire economy.[105]

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100. Ibid.
101. Ibid., p. 63.
102. Ibid
103. Ibid.
104. Commission of the European Communities, ESPRIT for Europe's Future, (Brussels), 1984.
105. Ibid.

No doubt this entire trend toward privatization was influenced by the ideologies of both Prime Minister Margaret Thatcher and President Ronald Reagan. In fact, it was not insignificant in gaining support for EC high-tech programmes and backing for the more revolutionary reorientation towards a revived laissez faire Europe and Euromarkets. In effect, it meant a decentralized transfer of power by the states to the more energetic, dynamic and reinvogorated European high-tech collaborations, accomplished through a community-based harmonization of markets into one common domestic market.[106]

EUREKA

The White Paper and the Single European Act evolved in parallel with the appearance of Eureka. Eureka meant the further stimulation of European industry through an essentially market- oriented move.[107] Eureka was merely the result of the realization that European integration had not been adequately exploited.[108] The initial idea was to build a programme where decisions would be made essentially from the bottom up. It was meant to bring order into intra-European competition and make it better equipped to deal with international competition.[109]

Moreover, the Eureka project was conceived by French President Francois Mitterrand, not long after Ronald Reagan's March 1983 "Star Wars" speech. Eureka was to be the European answer to the American Strategic Defence Initiative (SDI) underlying cooperation on equal terms.[110] Eureka found favour because it addressed

106. EC Commission, The ESPRIT Programme, (Brussels. 1987).

107. Hubert, Curien, The Revival of Europe, in Andrew J. Pierre, ed., A High Technology Gap, (New York: Council on Foreign Relations, 1987), p. 58.

108. Ibid.

109. Ibid.

110. Ibid.

directly the commercial marketing and financing orientation of collaborative advance stage projects through fifty-fifty public/private funding.[111] By 1987, EUREKA had accepted109 proposals, valued at over five billion DM with predominant French involvement and other major participation by UK, West Germany and Italy. The priority projects covered every aspect of IT, lasers, robotics, biotechnology, environment and transport protection with two major endeavours gaining the largest support: artificial intelligence development and third generation robots and factory automation were chosen as the two cardinal priorities.[112]

In some ways, the SDI and EUREKA initiatives are similar, yet they differ in a number of essential aspects. First, EUREKA is a civilian enterprise while SDI is a military one. This is an important difference as far as the funds for each programme are concerned.[113] It matters less, on the other hand, to the industrialists who have been commissioned to run them. Both ventures are attempting highly advanced technologies and the stumbling blocks, whether civilian or military, are similar in nature. In any event, the impetus given to technological development, be it EUREKA or SDI, will benefit the same industrialists.[114] Another striking difference between Eureka and SDI can be found in their aims. SDI has attempted to organize a well-focused system of military defense; Eureka, on the other hand, has a less definite goal, for it is trying to give a general boost to industries in their civilian-oriented activities. It also aims to introduce modernity to the whole of European industry.[115]

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111. EUREKA, the Secretariat of European Research Agency, Brussels, 1987.

112. Ibid.

113. Ibid., n. 106, p. 60.

114. Ibid.

115. Ibid.

The third difference is that SDI was initiated by Americans and EUREKA by Europeans. Thus, it is natural that, however strong the links of friendship and the political and military agreements between the two continents, their focus would be different.[116] The EUREKA programme was officially created in Paris on 17 July 1985, at a meeting of the foreign and science ministers of 17 states. Since then, Turkey and Iceland have joined, raising the total number of partners to 19 (the EEC is also a member).[117]

At its second meeting in Hanover, West Germany, 1985, the Group adopted a ''declaration of principle'', which stated productivity and competitiveness of European industries as its objective. Along with this, industrial, technological, scientific cooperation regarding advanced technologies was also mooted, essentially directed at both private and public sector markets.[118] The Americans feel that EUREKA, ESPRIT and other EEC programmes are not all that successful as transnational technological efforts in what they term as a 'technology war'.[119]

RACE

The programme called RACE (R & D in Advanced Communications Technology in Europe) is Europe's attempt in the Information Age to rationalize its loosely coupled federation of Post, Telecommunications and Telegraph Companies (PTTs) and to develop a coordinated response to the Japanese challenge posed by Nippon

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116. Ibid.

117. M Lucas in Stephen Gill (ed.). Atlantic Relations: Beyond the Reagan Era, (New York: St. Martins Press, 1989).p.8.

118. Declaration of Principles Relating to Eureka. Ministerial Meeting. Hanover. Nov. 1985.

119. David Brandon. H. Michael Harrison A. The Technology War, (New York. John Wiley and Sons. 1987) p. 181.

Telephone and Telegraph Information network system.[120] In order to make two-thirds of their economies competitive and to provide employment for 55 per cent of their active populations, the EEC nations are dependent on information technology.[121] On the other hand, not one of these countries has a national market for tele-communications that amounts to more than six per cent of the world market, while the American market amounts to more than 35 per cent and the Japanese market to more than 11 per cent of the total world market.[122]

Europeans suffer from a threefold problem in the telecom field. (1) Quantitatively, the Community is scattered in 12 national pieces, in contrast to the single expanding American market. (2) Europe imports 50 per cent of its integrated circuits. (3) Finally, since Europe does not speak with a single voice, it cannot efficiently redefine and regulate telecom systems.[123] The main aim of RACE is to alleviate the ills. Technological developments, correlated to this initiative, have concentrated on high-performing integrated circuits, such as integrated opto-electronics, broadband switching, passive optical components, image coding and the technology of display on a large flat screen.[124] Over 100 European companies are already participating in this common development programme. This particular effort in favour of telecom is justified not only by the need to respond to very keen American and Japanese competition, it further allows Europeans to reinforce links between

120. Ibid., p. 178.

121. Ibid. n. 107, p. 56.

122. Ibid.

123. Brendan Cardiff, "Telecommunications-Deregulation and An EC Standard", European Affairs (Amsterdam), 3/1989, p.70.

124. David R. Warlock, "The Information Industry's Two 1992 Tasks", European Affairs, 1/90, vol. 4, p.99.

the Community's peripheral and central countries and, on a global scale, to narrow the gap between North and South.[125] Here, the transfer of telecom technology, both multilateral and bilateral, becomes both necessary and important.

Any discussion of the EEC's scientific and technical initiatives needs to mention two important programmes, BRITE and Stimulation. BRITE is, in large part, the equivalent of ESPRIT in the technical fields, such as new materials and new production techniques, that are not covered by ESPRIT.[126] The Stimulation programme is slightly different. It is more concerned with basic research and aims to stimulate cooperation among European scientists by helping them to realize common research projects.[127] Other long term programmes are also supported by the EEC, particularly studies on the production of energy by nuclear fusion, the European space project (ESA),[128] the technology update of the Airbus industry and other programmes.

The swift succession of events made technology a most favoured area in both national and European terms. From this advocacy of European solidarity in one sector, the trade vitality and prosperity of the entire Community became the subject of dialogues between national, inter-governmental and business leaders.[129] The evolution of European information and telecom enterprises was tied to gaining more markets, to further liberalization of domestic markets and, finally, to achieving a single market.[130]

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125. Ibid. n. 106, p. 57.

126. Ibid.

127. Ibid.

128. Ibid. n. 83, p.66.

129. Pari Patel, Keith Pavitt, "European Technological Performance: Results and Prospects". European Affairs 2/1989, pp. 56-63

130. Ibid.

In this FRG, too, has had a distinctive role to play.

FRG's Transfer of Technology

In a world marked, first by increasing interdependence as well as by the globalization of technological development and, secondly, by the stark gap between developing and industrialized countries, science, research and technology are faced with the challenge of making contributions, beyond national frontiers, towards the solution of problems in the Third World.[131] This is not only consistent with the pri of solidarity but also emerges from a joint responsibility for the peaceful co ence of nations.

The Federal Republic of Germany, therefore, took upon itself the task of moting the indigenous capacities and, thus, the faster development and prosp of Third World countries, through greater scientific and technological cooper with these nations,[132] so much so that the expenditure of the Federal Ministr Research and Technology on projects of relevance to developing countries is of the order of DM 100 million each year.[133] This expenditure complements th velopment work of the Federal Ministry for Economic Cooperation, which supports among other things, the development and expansion of the scientific and technological infrastructure (technology centres, research institutes) in the developing countries.[134] One of the main activities of the Federal Ministry for Research and Tech-

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131. Report of the Federal Government on Research 1988. The Federal Ministry of Science and Technology. FRG. p. 119.

132. Ibid.

133. Ibid.

134. FRG. Research and Technology. Information 21. Press and Information Office of the Federal Government. Bonn. October 1988.

nology is the transfer of scientific and technological knowledge in order to strengthen R & D capacities and the economic efficiency and competitiveness of the developing countries.[135]

Partner countries, in this sense, are mainly newly industrializing countries that have, at least in partial areas, attained an almost identical scientific and technological level. In Asia they are India, Indonesia, Korea and China; in Latin America: Brazil, Argentina and Mexico; in Africa and Arab countries: Egypt and Saudi Arabia.[136] The main subject areas connected with the promotion of scientific and technological cooperation with developing countries are environmental protection, energy (renewable and fossil as well as nuclear), biotechnology, marine research as well as space research and space technology.[137]

The scientific and technological relations between India and the FRG have shown that close contacts between scientists in different countries can lead to major advances.[138] In 1971, the Governments of India and FRG concluded an agreement on cooperation concerning the peaceful uses of nuclear energy and space research.[139] Another agreement, concluded between the FRG and India in 1974 further strengthened cooperation between the two countries.[140] In addition, there have been numerous

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135. Ibid;

'136. Ibid., n. 131.

137. Ibid.

138. 15 Years of Bilateral Cooperation, Scientific Research and Technological Development 1974-1989, BMFT 1990, p. 11.

139. Agreement Between the Government of the Federal Republic of Germany and the Government of the Republic of India on Cooperation Regarding the Peaceful Uses of Atomic Energy and Space Research, Bonn, 5 Sept., 1972.

140. Documention Agreement on Cooperation in Scientific Research and Technological Development, Government of India, 1988.

individual agreements between German and Indian research institutions, e.g., Indian Institute of Technology, Madras.[141] Bilateral cooperation now includes a large number of contacts and projects in many scientific fields.

During his visit to New Delhi, Federal Chancellor Helmut Kohl had a conversation with the then India's Prime Minister, Mr Rajiv Gandhi and announced FRG's willingness to contribute to India's modernization through technology transfer. In a joint statement, both sides confirmed their mutual interest in intensifying cooperation in science and technology.[142] On behalf of the German government, the Federal Minister of Research and Technology is the member of the Cabinet responsible for the implementation of these agreements.[143] The Union Minister of Science and Technology, Government of India together with several secretaries of Departments outside the Ministry of Science and Technology fulfil this task on behalf of this country. Under the umbrella of these two inter-governmental agreements, a series of special arrangements were subsequently concluded between research organizations or institutions acting as nodal agencies.[144] Through these special arrangements, official procedures were defined for the implementation of joint research projects and the exchange of scientists. Means were also provided for funding travel, assignments and special equipment.[145] In 1990, more than 120 joint projects were underway. About 200 scientists per year go to FRG for either short term visits or long term assignments.[146] The results of joint research have already been documented

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141. Ibid.
142. Ibid.
143. Ibid.
144. Ibid.
145. Ibid.
146. Ibid.

in about 600 publications.[147] They have led to the promotion of science, to new methods and applications in many fields and to a considerable level of technology transfer. As an important side effect, close personal relations have developed.[148]

Proposals of scientists or research groups of both FRG and India have laid down the path of joint activities. Fact finding missions of experts, bilateral seminars, workshops and symposia have been organized and used to explore common interests, to define joint projects and later on, to review and restructure on-going activities.[149] The areas of joint research have shifted with time and reflected the priorities set in the two countries. There have been occasions when the needs and priorities of both sides have not coincided.[150] Surprisingly enough, however, the two governments in most cases have given high priority to the same research fields, viz., contemporarily to biotechnology, micro-electronics, materials research, environmental research, marine sciences and space research.[151] There were, and are, however, many more areas in which joint research efforts have contributed, and continue to contribute, to solve problems posed by the societies of either country in an efficient and effective manner.[152]

Motives for Technology Transfer to India

The main motives of FRG's technology transfer to India are : (i) gain or profit

147. Ibid.
148. Ibid., p. 14.
149. Ibid.
150. n. 139, p. 15.
151. Ibid.
152. Ibid.

motive; and (ii) the opening of new markets for capital and goods.[153]

Table IX

Motives for Technology Transfer to India

	Very high or high significance	Less or no significance
Expected gain	63 (78%)	18 (22%)
Opening up of new markets	59 (73%)	22 (27%)
Reaction to trade-disturbances	45 (56%)	36 (44%)
Protection of existing markets	38 (47%)	43 (53%)
Adjustibility to competetion	38 (47%)	43 (53%)
Cost of wages	16 (20%)	65 (80%)

Table X

Motives for Technology Transfer to India

(according to branches and size of enterprises)

	in % of divisions of respective branches and size of enterprises					
	351/2	382	383	GU	MU	KU
xpected gains	100%	75%	73%	100%	82%	69%
pening up of new markets	80%	81%	73%	60%	79%	37%

53. An Emperical Survey of the Transfer of Technology from German enterprises to India as well as a Report and critical analysis of India's Technology Policies with Special Reference to their Contribution to Reducing Technological Dependence. (Regensberg: Verlag. 1988).

Reaction to trade-obstacles	50%	78%	53%	60%	61%	47%
Protection existing markets	60%	62%	33%	80%	58%	25%
Adjustibility to competition	30%	66%	53%	50%	55%	37%
Cost of Wages	30%	28%	13%	20%	24%	12%
No. of Divisions	10	32	15	10	38	32

GU = Big enterprise — Großunternehmen — 351/2 = Chemical Industry

MU = Middle enterprise — mitlere Unternehmen — 382 = Manufacturing Industry

KU = Small enterprise — Kleinunternehmen — 383 = Electronic Industry

Looking at further main and subordinate moties of FRG's technology transfer to India, TableXI [154] will explain it further that the main objective of 20% of all small and middle enterprises and electro-enterprises increase in compensation.

Table XI

Main Motive — Subordinate Motive

No. of heads % of all heads

No. of Divisions		in %	A	B	C	D	E	F	G
A	5	6%	-	60%	80%	-	20%	40%	
B	17	21%	24%	-	29%	53%	-	24%	47%
G	16	20%		19%	31%	37%	31%	-	6%
A+B	12	15%			75%	92%		33%	83%
B+G	16	20%		19%		50%	56%	-	19%
A+G	3	4%		33%	67%	67%	-	-	

154. Ibid., p. 120.

A+B+G 7	9%			43%	57%		29%	
Sonst. 5	6%	20%	28%	40%	20%	-	28%	28%

A = Protection of existing goods market

B = Opening up of new goods market

C = Adjustability to competition

D = Reaction to trade obstacles

E = Safety of transportation of raw materials

F = Cost of Wages

G = Expected gains

Further, the main motive for technology transfer to India (according to the branches and size of enterprises) is explained by Table XII[155] where the symbol of explanation is the same as in the preceding table.

Table XII

Main Motive for Technology Transfer to India

(according to branches and size of enterprises)

in % of all divisions of respective tranches or size of enterprises

	351/2	382	383	GU	MU	KU
A	-	12%	6,5%	10%	7.5%	3%
B	20%	19%	40%	_	24%	22%
G	10%	6%	20%	10%	21%	22%
A+B	20%	22%	6,5%	20%	21%	6%

155. Ibid., p. 123.

B+G	30%	25%	6,5%	20%	13%	28%
A+G	10%	-	6,5%	20%	2,5%	-
A+B+G	10%	13%	6,5%	20%	8%	6%
Miscellaneous	-	3%	6,5%	-	3%	12%
No. of heads	10%	32	15	10	38	32

Therefore, 15 per cent of the enterprises emphasize equally the protection of existing and opening of new goods markets; over 80 per cent put additional emphasis on increase in compensation.[156] The objective of maintaining the existing goods market through technology transfer has basically changed in the past 60 to 70 years. Contemporarily technology exporters are necessarily on the offensive. They wait to open up new markets. The main and decisive objectives of FRG's technology transfer to India have been the expected profits out of selling technology.[157]

Forms of Transfer

There are three main kinds of transfer from FRG to India: (i) via multinationals; (ii) joint ventures; (iii) direct investment.[158] Much of the discussion about technology transfer and many policies in developing countries which attempt to regulate it, start from the assumption that technology is mainly transferred by large multinational companies to their wholly owned subsidiaries or to joint ventures.[159] The technology transfer then, goes along with capital investment, supply of machinery and equipment and often also materials and components for ongoing production.

156. Ibid., p. 124

157. Ibid., pp. 124-125.

158. Ibid., pp. 124-125.

159. Hoffman, Lutz, "A Transfer of Technology to India: A European Perspective", Regensburg, 1984, unpublished paper, pp. 8-14.

Management, organization of the production process, marketing and training are all, more or less, guided by the technology supplying company. This is technology transfer in a highly packaged form[160] And this is the form large German MNCs adopt for transfers of technology to India.

There are basically two points of criticism against this form of transfer. First, the technology transfer and its renumeration can hardly be separated from the investment and trading activities. It, therefore, is not possible to assess whether the price paid for the technology transfer is adequate or too high. This can easily arouse and has aroused suspicion that the technology is overpriced resulting in too high a price of commodities produced with such technology, too little transfer of know-how for a given amount of expenditures and unnecessarily high out flow of exchange from the technology importing country.[161] The second paint refers to problems of acquiring the technological know-how, which may arise if the entire decision process regarding the choice of the technology, its implementation and its operation is in the hands of the technology supplier.[162] Ultimately, technology transfer should enhance the technological capability of companies in the technology importing country. This can only be achieved if the technology importers acquire not only the know-how but also the know-why and learn to choose, to adopt, to modify and later on to improve technology or to even develop technologies on their own.

Direct investment was definitely the major channel of technology transfer to India during the first two decades after independence but now more and more joint

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160. Ibid., p. 9.
161. Ibid.
162. Ibid.

ventures are being used as a means of technology transfer.[163] Since 1984-85, the number of joint venture approvals have almost doubled, but the total amount of capital invested has remained low.[164] This seeming contradiction of joint ventures, as a form of technical industrial cooperation, transfer of technology and low German investment has several facets. On the one hand, German collaborators meet the high expectations, make the best high-tech partners, are considered cooperative and helpful, and result oriented.[165] The Germans, on their part, think highly of Indian performance as, partners but the profitability of the Indian joint ventures is below that of the parent company and even the international average.[166] Yet, it is a forum repeatedly used. This is because of its long-term effect and not so much for its short-term impact. In the final analysis, technology transfers through Indo-German joint ventures are not only "foreign exchange neutral" from the Indian point of view, but instead contribute directly to the improvement of the Indo-German trade balance.[167]

Vintage of Technology

In the case of FRG, only 12 per cent of the transferred technologies have been more than five years behind the latest development.[168] FRG's chemical industry has transferred the highest percentage of the most recent technologies; the electrical engineering companies, on the other hand, have been below the average in transferring the most recent technologies.[169]

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163. Ibid.
164. Ibid.
165. Ibid.
166. Ibid.
167. Ibid.
168. Ibid.
169. n. 161. p. 21.

Direct Benefits

Direct benefits for the Germans are either in the form of a lumpsum payment or a royalty, as referred to earlier in this chapter. Indian technology import policy prescribes a maximum rate of 5 per cent on ex-factory selling price, net of excise duties minus the cost of standard bought-out components and lent cost of imported components, and a maximum for combined lumpsum royalty payments of 8 per cent.[170] Higher rates are possible if the technologies are considered to be of high priority for India. For technologies which already have been imported by other companies, Indian authorities usually approve royalties considerably below five per cent.[171]

Direct Costs

The absolute extent of direct costs cannot be assessed because the transfer costs of men, human resource transfers and some materials cannot be assessed.[172]

Mechanism of Control

Although the mechanism of control ensures overall success for the supplier, its exact impact cannot be quantified. Ninetyfour per cent of all enterprises want control over technology through either quality controls or export restrictions.[173] For a majority of the electro-industries, the control mechanism is considered particularly, important.[174] Control, with a high degree of compensation for technology transfer, is the aim of the majority of the German enterprises. This is especially conducive

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170. Ibid., p. 22.
171. Ibid., p. 39.
172. Ibid.
173. Ibid., p. 40.
174. n. 155, p. 108.

for long-term technology transfer agreements.[175] A strong measure of export control has been the COCOM. This has already been referred to in the last chapter with reference to the role of the US. The experience with European nations confirm the perception that the US oversteps its role in linking political issues with economic measures. COCOM ambivalently links national security and foreign policy with trade controls. There is a distinct difference between the US and the European nations on the use trade controls for strategic reasons.[176] Nevertheless, transfer of technology for such items as electronics, telecom equipment and the like, which could be considered as 'militarily useful goods', can be restricted for reasons of security.[177]

Business organizations bear the costs of export controls. These costs can be substantial. The imposition of retrospective export loans can seriously undermine a company's credibility.[178] Therefore, the security political-economy linkages became tight and overwhelming under the banner of COCOM, preventing collaboration in new technologies. These have to be looked into far more carefully.

Impediments to Technology Transfer

Technology transfer can be influenced in both the economic and institutional spheres through governmental policy. In order to improve or develop technology transfer, one must be aware of the hindrances facing both the importers and exporters of technology.[179] The most obstructing factors for the German electro-in-

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175. Ibid., p. 112.

176. Ibid., p. 114.

177. The Economist, (London), 30 January, 1982, p. 50.

178. Lowe, AV." Export Controls: A European View Point", International Journal of Technology Management, (Geneva) p. 74.

179. Ibid.

dustry for example are: (i) bureaucracy, (ii) taxation policy; and (iii) licensing policy in India.[180]

On the other hand, FRG needs to be far more aware of Indian conditions and attitudes of entrepreneurs, as well as be better informed of Indian policies and Indian needs both at the government level and the level of private enterprises. In technology transfer, there ought to be equal partnership for scientific interest and not mainly for commercial or economic development, according to Stefan Schneider, Federal Ministry for Research and Technology, Asia Desk.[181] Further, according to him, even in the environment of restructuring and redefining North-South, and East-West relations, India is not losing importance. But he recommends transfer of technology within India, between the scientific and industrial community its, and a rational system of contract research.[182]

As transfer of high technology carries with it its own imperatives, as repeatedly pointed out, it falls within areas of both military and civilian technology. Therefore, there is a restraining factor even for the Germans, especially in the wake of the impact of the Gulf War of 1991, when about 170 West German firms were under investigation for their role in transferring to draw the means to manufacture chemical, biological and nuclear weapons.[183] The West fears that as tensions continue to cease between the East and West, the military build-up in the developing world will become a principal threat to peace. Added to this is the perceived need for new

180. n. 155. p. 126.

181. Ibid., p. 137.

182. Interview with Stefan Schneider. Federal Ministry for Research and Technology. (Bonn). 23 October, 1992.

183. Ibid.

export controls which requires more reliance on multilateral diplomacy and international institutions.[184] In the military-civilian nexus of high-tech transfer, in Indo-German relations too, non-proliferation has become the major issue, mainly because the industrialized Western nations have made it so. In fact, the US has taken a deterministic role in linking technology transfer with the non-proliferation issue.[185] A cooperative approach even among the members of the Atlantic Alliance cannot really work, because of the prevailing domestic economic recession. Germany would have to relegitimize its policies on high-tech transfer to India to increase its threshold and work out a politico-legal framework.[186]

According to Dr. Herkommer, a member of the Deutscher Bundestag, regional instability influences German foreign policy towards India. He, however, seemed to think that German scepticism of transfer of technology to India was doubtful because of the India's peaceful nuclear explosion of 1974.[187] He tended to identify the motivation of Germany to transfer technology as not only for profit but to decrease tensions in the area. Though not very clear on either the motivational aspect or the end result, he emphasized the connection of research and transfer between the industries and the universities or technical schools. He also emphasized environmental protection and the greenhouse effect on any new technological transfers. He strongly felt the need for even better Indo-German diplomatic relations as part of foreign policy.[188] Further, Dr Herkommer was convinced that once new technology was trans-

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184. John McCain, "Controlling Arms Sales to the Third World", Washington Quarterly, Spring 1991, p. 79.

185. Ibid., p. 86.

186. Interview with Klaus Becher, Forschunginstitut der Deutsche Gessellschaft für nuewärtige Politik e.v. Bonn, 24 October, 1992.

187. Interview with Dr Herkommer, Deutscher Bundestag, Bonn, 25 October 1992.

188. ibid.

ferred, the market would regulate it. Referring to the vintage of technologies transferred, he felt that Indian scientists would not tolerate old technologies. He also felt that the scientific capability of Indian scientists could not possibly be ignored. He believed in the sharing of knowledge between Indians and Germans but felt that it would be harder for them to improve relations further once Germany became part of the new European Union, as Germany would no longer be a totally individual entity.

On the other hand, Dr Else Fricke of the Department of Technology, Friedrich Ebert Stiftung, Bonn, opined that technologies of old vintage are transferred as weapons, chemicals, etc., for war.[189] Further, as the ecological issue is of importance to Germany, industries went over to the Third World nations with technologies which had met resistance within Germany. So the logic of production elsewhere of such industries was first in East Germany and East Europe and then in Asia and Africa. According to her, computer software from India is a success at the level of global networking and that Indians had high skills, education and low-cost productivity and, therefore, it made it easier for German companies to transfer technology to India.[190] Microelectronics, according to Dr Fricke, is a human-oriented technological development and easy, too. Politically, India, being a democracy, is an open society and, therefore, found it easier dealing with Western nations.[191]

The Indo-German Export Promotion project (IGEP), like Dr. Fricke, put across

189. Ibid.

190. Interview with Dr Else Fricke. Department of Technology. Friedrich Ebert Stiftung bonn 21 october. 1992.

191. Fricke. Else Konzepte zur Gestaltung von Arbeit und Technik aus Wissenschaft und Praxis bona. Friedrich Ebert Stiftung. 1991. p. 57

the view that Indian software exporters have credibility and competence but not the wares.[192] Again, similar to Dr Fricke's views, Ms. Kavita Kaushik, Sector Manager, IGEP, Computer and Software/Hardware, is of the opinion that incentives should be given to small and young companies, and middle-level enterpreneurs ought to be encouraged. [193] According to her, the technological parks in Trivandrum, Bangalore, Bombay, and NOIDA have performed wonders in absorbing information, especially computer technologies and the yojana system. Software in Pune technological park too has been fairly advanced . In adequacy of awareness of Indian capability on the part of Germans, and of German trends on the part of Indians and a twenty-yea gap between the Asian Giants and India have to be over come if the full potential of Indo-German inspiration is to be realized. [194]

Dr Markus of the Economic Ministry of Germany (BMFT) stressed on bilateral cooperation and targeted India and Brazil as threshold countries. According to him, cooperation between India and Germany includes space research, energy, biotechnology, environment protection, fundamental research, transportations and the recent focus is on medicine. The BMFT did not really cross over into military research and, therefore, COCOM was localized to prevent abuse of high technology.

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192. op. cit..

193. Computer software Info-letter IGEP. New Delhi Edition 2. March/April 1992 p. 13

194. Interview with Ms Kavita Kaushik. Sector Manager. Computer Software/Hardware. IGEP. New Delhi 16 April 1993.

CONCLUSION

There is no doubt that Germany, after World War II recontructed its economy and re-emerged as an economically powerful developed nation in the western bloc. The prime secret of its success in emerging as an industrial giant in less than one and a half decades after the war was its sharp focus on development in the civilian industrial domain. It had practically very little liability in the defence arena.

However in the 1970s and 1980s, like Japan and the US, FRG made strident progress in several sectors of dual-use high technology.

Germany happens to be the second highest donor (the US being the first) of official development assistance to India. It has steadily increased from DM 178 million in 1980-81 to DM 364 million in 1990-91. The main motive for development assitance has been to help speed up the processes of India's economic modernization. In 1992, German bilateral development financial cooperation which added up to DM 555 million could have been more if the German Government were convinced that India would not divert it to military purposes. Over the past twenty years Indo-German trade has increased six times over from a total of less than one million DM in 1969 to more than billion DM in 1989. But again the share of Indo-German trade in Germany's total trade was only 0.5% which is negligible and needs to be improved drastically. As yet India's present on-going economic liberalization has not met with any discernibly encouraging response from the German industry. But as the processes of privatization with external economic factors gain momentum, and as a result, negative factors, such as those of bureaucratic red-tapism subside, it is hoped that German private sector would find Indian market tempting enough to invest large equity and technology of which some evidence is clearly forthcoming even if in a small measure at this stage.

German science and technology capabilities are based upon sound fundamental reasons, and over the years, have been oriented towards high technology. FRG's research and development projects are also geared to be in harmony with EC's framework programmes for high technology of use both in civilian and military domains such as BRITE, RACE, ESPRIT, and EUREKA. There is also well organized interaction between the industrial and academic specialized institutions. With the result that Germans aspire to do better than the Americans and Japanese.

However, it as noteworthy that Germans have not succeeded in outpacing the Japanese and Americans in several key areas of high-technology, viz. informatics, artificial intelligence, robotics but they are leaders in some such as laser sensors, chemicals and pharmaceuticals and continue to be in the race in other areas with their industrial competitors.

From among the major EC member stats, FRG has given evidence over the preceding two decades of evincing interest in India's industrial development, and have made satisfactory progress, in any case more satisfactory than the other members of the EC. FRG is presently preoccupied with the economic reconstruction of its eastern part, and is also for historical reasons committed to making success of economic reforms in Central and Eastern Europe. But FRG is now in the throes of recession. Despite these liabilities, one fact on which most of the European specialists tend to agree is that of all the major world powers, if any one of them has bright prospects of emerging as a world economic giant to be reckoned with, this is unified Germany. German experts and others agree that by the turn of this century they would attain the status of number one economic power in Europe, and one among the three in the global economic triad.

About India, perceptions vary. Even if liberalization is taking place on high speed, yet it is not attracting foreign direct investment or technology from Germany and other Euro-Atlantic powers in the same way as China and Indonesia are doing. Several reasons are being cited which continue to impede India's openness to the global economy—(a) India has commenced rightly on a programme of delicensing most of its industries. One prime example that could be give in this regard of the recent collaboration between Lufthansa and Modi's (Modi-Luft). But then at the policy making level, steps to dismantle the regulatory mechanisms such as the Directorate-General of Imports and Exports have not yet taken effect. And it is well known that the bureaucratic machinery in adept at framing new regulations in place of those which have under the new policy been wound up. (b) India continues to be rated as a high cost production country. The cost of indigenous imputs such as steel and other raw materials required by the industry in the high-tech domain is higher than in other Asian countries. And still further, despite low wages, productivity per unit is nearly half of that in the Easn Asian NICs. (c) And more than anything else, India's infrastructure continues to be inefficient, slow and sluggish.

As long as the foregoing factors continue to affect our liberalization processes, the German political class, pursuing Realpolitik, will not give up its rhetorical support to India's development endeavours, but the German economic class (known for pragmatism) will keep itself away from getting deeply involved in our ambitious plans at integrating our economy with the global mainstream.

Under the circumstances what is needed is that India projects its image as a country which is fast mooving out of the grooves of state-director economy, and has already moved long enough in the direction of its emancipation from the bureaucratic wranglings. There seems to be some evidence of its success in this regard. In the US official thinking today, ''India's economic liberalization measures are 'the real thing, and India ranks among the top fine 'hot' countries for foreign investment. This is in sharp contract to the 113th position India held about a year ago.''[195] Furthermore, India provides a large market of nearly 150 million middle-income people, whose consumer tastes and interest are nearly comparable with those in Europe and the US. Therefore, it would be in Germany's own interest as well that it hastens its entry in a big way in the Indian market. Too much of delay may perhaps run counter to its interests,for the Japanese are watching on how new economic policy is being shaped up in this country.

195. Confedration of Indian Industry, International Institute & Konrad Adenauer Stiftung, Seminar on A FREE Market Economic: Challenges Ahead—Background Papers (New Delhi), 21-22 September 199, p.18.

Chapter IV
Computers Case Study I

Definition

Advancing technology radically changes society. Social, economic and political issues intersect. At each intersection are science and technology aspects, influencing what happens, introducing problems, potentials for their solution and new possibilities for the way things will have to be done.

One key impact of technology on society is the way it is altering international relationships. Technology is accelerating change at a rapid pace. One of the major areas of technological change and challenge is the computer. It is a part of the information technologies which also invests into industrial technologies. Transfer of technology is a complex phenomenon.

It is universally agreed that computers are a means to innovation in virtually all undertakings, but there is less unanimity on exactly what is meant by the term 'computer'.

In the early 1960's, a computer was perceived as a stand-alone main frame unit [such as the International Business Machines (IBM) model 650] weighing several tons that was housed in a large specially constructed area. In the early 1970s, however, it became possible to place all the logic and memory of a computer on a single chip of silicon approximately 0.25 inch square. The advent of single chip microprocessors and microcomputers made it possible to incorporate the computing power of a mainframe into such products as microwave oven, controls, and handheld calculators. Today, a computer is thought of as a relatively inexpensive machine in the U.S., West Europe and Japan. Its computing power can be 500 to 1,000 times that of an early frame.

Thus, a computer encompasses a range of devices from supercomputers, which cost millions of dollars and are used for such things as sophisticated weather forecasting to an increasingly popular tool located in the home and on the job, e.g., embedded microprocessors found in home appliances and automobiles, that are hardly recognizable to the user as computers.

In this thesis, the term 'computer' denotes an electronic device that accepts, stores, retrieves and processes data according to programmed instructions. The structural elements of a computer include hardware, the basic processing unit,and peripheral devices, such as a keyboard (or other input medium), modem, mass storage or printer (or other output medium) and software, which give the computer instructions.

Computer Technology Developments and Trends

Hardware

More than four decades ago—in 1945, to be precise –John Von Neumann proposed the first stored-programme digital electronic computer containing both data and instructions in the same memory. Since then, the technology of digital computers has undergone at least three significant changes. In the late 1940s, computers were based on vacuum tubes. In the late 1950s, there was a general shift to transistors. This was followed by the appearance of integrated circuits in computers in the 1960s.[1]

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1. P.M. Russo. ``VLSI Impact on Microprocessor Evolution, Usage, and System Design''. IEEE Journal of Solid-State Circuits. (California) SC-15 (4). 4 August 1980. p.405.

In the first 15 years after the invention of the integrated circuit in 1958, the number of transistors that could be placed on a single chip doubled every year. In the past few years, this rate has slowed to doubling every 18-24 months.[2] Twenty-four years of technology advances have produced four generations of chips of increasing device complexity: discrete components, containing one active element group AEG per chip (that is the lowest level of electronic circuitry e.g. one logic gate or one bit of active memory); small-scale and medium-scale integration, with up to 1,00,000 AEGS per chip. In the mid–1980s, VLSI (very large scale integration) technology is expected to put one million AEGS on a single chip.[3]

At the same time, the cost per AEG has been reduced manifold since 1960. This trend will continue through the VLSI era.[4]

Computer memories, in particular, have undergone considerable change in the past 40 years. Foe example, while till recently computers relied on magnetic cores for rapid access memory, now memory technology has advanced to bipolar and metal-oxide semiconductor circuits.[5] These successive stages in the development of computer technology have increased the speed of computer operation and vested the computer with the ability to package more computational power and data storage in the same volume. The historical trend [6] shows that by the late 1970s it was pos-

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2. P.M. Russo, "VLSI impact on microprocessor evolution, usage, and system design", IEEE Journal of Solid-State Circuits, SC-15 (4), 4 August 1980, p.405.
3. J.D. Meindl, in Arthur L. Robinson, "One Billion Transistors on a Chip?" Science, (Washington D.C.) 223, 20 January 1984, p.268.
4. Ibid, n. 1.
5. J.P. Martino, Technological Forecasting for Decision Making (New York: American Elsevier 1972).
6. M.E.W. Jones, Holton R. Stratton, "Semi-conductors: the key to computational plenty", Proceedings of the IEEE, 70, 12 December 1982, p.1402.

sible to purchase 100 times the computing power of a 1950s mainframe computer at roughly the same cost. For mini-computers, the cost decline has been quite dramatic.

Significantly, these increases in the functional capability of computers have followed a steady and predictable trend—a trend seemingly unaffected by the radical changes in technology that have occurred since 1945. Subsequent studies show that progress has continued at a steady rate, despite the introduction of different technical approaches.

It can be inferred that advances in the technical capability of computer memory are largely independent of the technology used to create that memory. That is, even though we may be approaching the limits of silicon technology, it is possible to predict the availability of 1-,4-, 16-, and 64- megabit memory chips before the turn of the next century, our inability to forecast the particular technology or technological breakthroughs that will lead to the development of these chips notwithstanding.[7] Clearly, the ability to meet the demands of the expanding knowledge industry over the remainder of this century will not be limited by memory performance. Similarly, the historic exponential increase in the number of logic gates on a chip will continue for at least the next few years, leading to logic chips with several million transistors by the late 1980s.[8]

The effect of these advances in computer hardware on the commercial world has been open to the vast market of small business and individual professionals that had never been able to afford the computing power of a mainframe and to move

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7 Op.cit.

8 Ibid. n. 6.

the computer out of special air-conditioned rooms and onto the desks of individual users. Similar advances in software are rapidly taking over the role once performed by a team of computer experts, allowing individual users with little or no computer training to make use of data processing capabilities that had once been the private preserve of large corporate data processing departments.

In the consumer world, semiconductor technology has opened markets for applications that had been impractical from a cost standpoint before the advent of the microprocessor. Since then computers have found their way into households in the form of hand-held calculators, digital watches, computer–controlled cameras, appliance controls, video games, home computers and pre-school learning devices that reproduce human speech. These applications are but the tip of the iceberg.[9] As it becomes possible to put more and more transistors on a chip, microcomputers will become even more powerful: For example, they will have wider data paths, larger address spaces, and more comprehensive instruction sets, with attendant increases in functional capability.[10]

Software

Continued expansion in the use of computers is dependent on the ability to conceive and develop new software that can fully utilize the capabilities of the hardware being developed. However, so far, at least, software development has not matched the steady performance and cost improvements in hardware over the past three decades.[11]

Essentially, the history of the evolution of software comprises a number of at-

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9. P.M., Russo. Ibid., n.1., p. 405.

10. Jones et al. p.1402.

11. Fred J. Bucy, "Computer Sector profile" in Technological Frontiers and Foreign Relations (National Academy of Sciences, Washington D.C., 1985), p.53.

tempts to "educate" the computer so that commands can be phrased in human terms of communication and internally transferred to machine levels of communication for execution. Of course, a reverse translation of the output, from machine language to the human level, has to occur if the results are to be meaningful.

Several interrelated reasons can be cited for the failure of software productivity and performance to keep pace with hardware. Over the past 30 years, programming has borne at least as much resemblance to art as to science, that is, although a number of methodologies exist for writing software, no single methodology has been established that is effective for developing many different types of software. Because of these limitations, software products until recently have had to be tailored for specific applications on specific pieces of hardware. Accordingly, software costs have not benefited from the experience - curve effect that has driven down hardware costs so dramatically.[12]

In the commercial sector, software designers now save time by re-using proven, already debugged routines on modular and portable software. Specific application packages, once developed, enable an increasing number of users to solve their problems without having to program the computer. The more times a programme is executed without modification, the greater is the productivity of the original design team. Specific examples of these phenomena are the uses of spread sheets, text processing, data base management, and graphics software packages on professional and home computers. Software development is in the process of evolving from its present skilled-craftsman service context to an industry that offers well-defined, competitively produced commodities.[13]

12. Ibid.

13. Ibid.

In the military sector, the cost of developing software in 1970 was roughly half of the hardware cost. By 1985, software development costs exceeded the cost of US Department of Defense (DOD) computer hardware. In fact, software is one of the most serious problems in the DOD's use of high technology. This is no surprise, since within the DOD there is a 12 percent annual increase in the demand for software, yet there is only a 4 percent annual growth in DOD's ability to supply software. Cost and time overruns are the rule rather than the exception in regard to software.[14]

Other software-related problems confronting the DOD include technology transfer, the burgeoning number of different computer languages and dialects, the lack of reliability and adaptability of software, the dismaying slow rate of transfer of modern software technology into industrial and military practices, and the increasing technological complexity of computers and software required to meet future needs.[15]

A number of techniques have been used by DOD in an attempt to solve the logistics problem of catch-up in terms of R & D. One of these, the ADA (trademark of DOD) project, is an effort to design a common language for programming support-environment. Since the goals of the defence and commercial sectors are the same—programme reliability and maintainability, concern for programming as a human activity, and efficiency—concepts and techniques developed in ADA have potential commercial application.[16]

Another DOD initiative announced in 1983, Software Technology for Adapt-

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14. David H. Brandin & Michael Harrison, The Technology War, (New York : John Wiley & 1987), p.121.
15. Ibid, p. 122
16. Ibid. n. 11 p. 54.

able Reliable Systems, addresses a wide variety of issues in the technology, human resources and business aspects of computer software development that may also be applicable to the commercial sector.

A common problem in both the DOD and commercial development is the difficulty in timely determination of software errors. As a software project proceeds to later stages of development, the range of costs to correct an error increases sharply.[17]

One step further in software development is artificial intelligence (AI), a term first used in 1986. The capabilities of AI systems extend beyond numerical calculations and information retrieval by processing non-numerical data, such as sentences, symbols, speeches, graphics and images AI systems, with their expanded use of computational and storage capacities, were once a phenomenon found only in laboratories that had huge computers. With the rapid advances in solid-state micro-electronics discussed above, however, AI systems have become available for commercial use.

The central goals of AI have been to make computers more intelligent (i.e. to act more like humans) and to understand the principles that underlie human intelligence. AI deals with problems in such areas as game playing, theorem proving, general problem solving, perception (speech and vision), natural language understanding, and expert problem solving. Traditional computer programmes are deterministic; that is, all inputs must be entered before a programme will run. A single answer will result from this input. AI systems are not deterministic and are far more applicable to "real world" situations because answers (with a range of possible alternatives) can be based on partial information. This is why AI is all the more value- loaded in

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17. Ibid., p.55

terms of technology transfer in computers from the U.S. to India.

The symbolic relationship between micro-electronics and AI is politically recognised in Japan where in 1982, a research project for the fifth generation computer-system was initiated and the Institute for New Generation Computer Technology was formed.[18] The initial research goals of the project are to investigate architectures suited for logical inference and data base operations (particularly, parallel architectures that can achieve extremely high performances), design a logic programming language suitable for knowledge representation and inference, and design a workstation containing a sequential inference machine.

The potential applications of AI are numerous in both the military and commercial fields but much work remains to be done in refining the generic rules of logic (i.e., how the human mind bears and reasons) and in transferring this knowledge to the computer system for each field of application.

Data Explosion

The value of a computer lies in its ability to accept, store, retrieve and process data. The essence of the "computer revolution" lies in the distribution of this computing capability among millions of individual users. In solving the problem of the individual's ability to acquire data, however, new problems have arisen.

The growth in the availability of raw data places a premium on more efficient organisation of data bases and on the development of software that will allow users to extract information from these data. It also raises a host of political issues

18. Hearing before the Subcommittee on Science, Research and Technology of the Committee on Science, Space and Technology. U.S. House of Representatives 101st Congress. 28 June 1989 No. 45 p.67

related to the flow of information outside national boundaries, the individuals' right to privacy, the security of data stored in computers, and the concept of information as a commodity with intrinsic value. Full treatment of the telecommunications impact will be dealt with in the next chapter.

Technical Skills Requirement

There is, surprisingly a great amount of debate concerning the skill levels in American society, the ability to achieve the technological breakthroughs and the attendant benefits of new computer technology. There is serious thinking about the lack of technological innovation placing the US at a competitive disadvantage in the world marketplace. There are others who argue that the spontaneous corrective mechanisms of American society are adequate to meet these lags. Policy issues begin to surface when the discussion turns to the gap between supply and demand. This discourages technological transfer of computers from the U.S. to India, as there is high urgency to protect themselves in international trade or more specifically, intellectual property rights.

This is also the juncture at which the COCOM control of exports may have to be considered. Basically, it is the instinctive reaction of both the U.S. Government and the industry, the former for reasons of national security and protection of its foreign policy, the latter because of competitiveness in the world market. [19]

Again, as said earlier productivity-enhancing investments should be increased and the nexus between industry - academia should be utilised to the maximum. Several

19. H.R.656- The High Performance Computing Act of 1991. Hearing before the Committee on Science and the Subcommittee on Technology and Competitiveness of the Committee on Science, Space and Technology, U.S. house of Representative 102nd congress. 7 March 1990 p.201.

gaps can then be bridged.

The Technology Outlook

One way to view the evolution of computer is to capture its three landmarks. The first of these waves began around 1940 and focussed on engineering efforts to build computers that could perform complex calculations not possible by other means. The second of these waves started in the early 1960s and focussed on machine productivity, e.g. the IBM 360 family. In this era, computers served the needs of large institutions. The last of these waves to date is the era of user-friendly computers. In this, the ability of individuals to cope rapidly with a complex situation, or ''people productivity'' is the key factor. This latest wave will be driven by new concepts in the organisation of software that will soon begin to influence significant changes in hardware. It will ultimately bring down the cost of computing power throughout all segments of society. This will, in the ultimate analysis, be the saving factor in the acquisition of computer high-technology by India. A number crunching at the level of cost-benefit analysis, by reducing costs will benefit Indian technology acquisition in computers.

Political Impact of Computer Applications

Further, the microcomputer and microprocessor have dimensions and power requirements that make them applicable to almost any human activity. Consequently, almost all sectors of modern society are seriously considering how to perform traditional functions more efficiently through computer usage or how to perform functions formerly considered impossible.

One of the areas in which computer application has made an impact is education and training. Computer-aided education in schools is fast becoming a necessity. In training educators, too, computers are necessary.[20] There are however, various hinderances in this, which can be overcome.

At factory premises, islands of automation in the manufacturing process have been established which eventually can be linked together to form total computer-integrated manufacturing (CIM) systems.[21]

The key factors in manufacturing automation are quality and reliability and in the factory, highly complex computerized systems could be built and programmed at reasonable cost and convenient size. The new technologies offer the potential of turning any type of manufacturing into an automated process, even if production batches are quite small.[22]

Recently, of course, computer-aided design (CAD) has emerged in which design drawings could be constructed on a video screen, manipulated, updated and stored electronically. The concept has now been extended to computer-aided engineering (CAE), where methods of prototyping could be carried out on the screen, without having to experiment with the actual material. The result has been better products designed more quickly and cost effectively.

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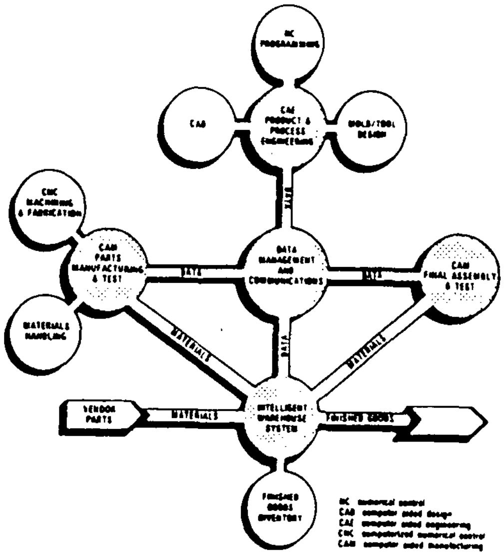
20. M. Ploch, "Micros Flood Campuses", High Technology, March 84, p.47
21. G. Charlish, "Computer-aided Design" Financial Times Survey, (London) 12 January 1984, p.11.
22. I. Rodger, "Manufacturing Automation", Financial Times Survey 12 January 1984, p.1.

Another extension is computer-aided manufacturing, which uses the same collection of comprehensive information about the product as CAD and CAE to derive molds, die tools, and machining strategies. A further concept in manufacturing automation is that of flexible manufacturing systems (FMS), where production machines are linked by means of handling devices (such as robots) to transport systems and, communication lines, with overall control by computer. At any moment, the computer knows exactly where each component is and what is happening to it. The result is a reduction in lead time, work in progress and direct labour as well as more new products. So far, only about 100 FMS are in use worldwide.[23]

''The major challenge now, and the major opportunity for improved productivity, is in organising scheduling and managing the total manufacturing enterprise, from product design to fabrication, distribution and field service''.[24] The final step in manufacturing automation, the linkage of islands of automation in a CIM system is illustrated in fig. 1[25]



23. A. Kochen. ''The Equipment Users''. Financial Times Survey 12 January 1984. p.111.

24. T. Gunn. ''The Mechanization of Design and Manufacturing''. Scientific American. September 1982. p.115.

25. Financial Times. 24 May 1983.

In the office, the impact of computer technology is powerful because one of the greatest productivity impacts of computers is primarily concerned with information and its dispersal. The office is where white collar workers spend 80-95 percent of their time, communicating and managing information.[26] The office environment of the future will utilize powerful, knowledge-intensive personal computation within a network of cooperating computers, and their users. A major increase in productivity will result from the ability to access large data bases containing information appropriate to the specific job function, and from doing so in an interactive query mode, performing what if analyses, and integrating data imagery with textual, numeric, and graphic representations, electronic mail, conferencing and filing increase productivity and communications. Consequently, these capabilities have a major economic impact.

Unfortunately, computer usage in the agricultural sector has been limited to a few innovations. But the agenda points to greater use to include even microelectronics technology. The purpose is to apply electronics technology to integrated production, finance and marketing information systems and further integrate this with computerized monitoring and control of crop and livestock equipment and production facilities.

The ever-present challenge facing the U.S. military is the fielding of affordable, effective, conventional and strategic deterrents to cover a wide range of scenarios. In the U.S. National Defense, computers and microelectronics are the major determinants of that capability and are growing in importance. According to the US, when properly used, technology can assure that superior performance is achieved and computers offer the same benefits in military applications as in the civilian

26. H.D. Toong and A. Gupta, "A New Direction in Personal Computer Software". Proceedings of the IEEE. 72(3), March 1984, p.379.

sector—speed, accuracy, flexibility and efficiency.[27]

The development of such technology is very much dependent on computers. During the last two decades, computers-particularly supercomputers like the Cray have become the main stay of defence-related R & D efforts. They are used for simulation and modelling of everything from high-speed, high-altitude aerodynamics to the effects of ocean currents on submarine detection capabilities. Supercomputers will play a major role in the design of the National Aerospace Plane (NASP), and are the cornerstone of nuclear weapons research at Los Alamos, Lawrence Livermore and Sandia National Laboratories. The Strategic Defense Initiative, too, relied on a network of computers called the National Test Bed, to simulate attack and defence scenarios that can be replicated in no other way.[28] It is for this reason that the US tries to protect its computer sector.[29]

It must be understood that high performance computing which comprises large capacity data networks and supercomputers and the software to exploit the capabilities of both, is evolving into a powerful engine of scientific and technological progress. Supercomputers play an important part in this. In some fields they are auxiliary aids; in others, they are the only means through which progress can occur.[30] Accelerated development of supercomputing eliminates barriers to social change

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27. A Joint Economic Committee Congress of the U.S., 101st session, Washington D.C.8 June 1984 High Technology Consortia: Federal role, p. 83.

28. Bruce Gumble, "Computers in Defense", Journal of Defense and Diplomacy, p. 18.

29. Computer Security Act of 1987 report by Subcommittee on Technology and Competitiveness transmitted to Committee on Science, Space and Technology House of Representatives 102nd congress, U.S. Govt. Washington D.C., 1992, p.2.

30. H R 656-The High Performance Computing, Act of 1991 Hearings before the Subcommittee on science and the Subcommittee on Technology and Competitiveness of the committee on Science, Space and Technology, U.S., House of Representatives , 102nd Congress 7 March 1991 US Govt. Washington DC. 1991 p.1

and advances scientific well-being of society.[31] Further, it is bound to lead to U.S.. economic competition. This Act (i.e. the H.R. 656) has the potential to extend U.S. technology leadership in high performance computing. It will also spur productivity in the U.S. via improvement in its educational infrastructure. The fear is that the current superior position of the U.S. in high performance computing will recede and give over to Japan and Europe [32]. The then Senator Al Gore, Tennessee, reiterated the above and underlined the need for U.S. to maintain its economic superiority and productivity.

U.S. Computing Systems Projects.

With the development of networking, cooperative university industry supercomputing through National Science Foundation (NSF), Department of Electronics (DOE), Defence Advanced Research Project Agency (DARPA) and National Aeronautics and Space Administration (NASA) programmes, the federal government does continue to support research on the same.[33]

The supercomputer is the precursor of major advances in the computer industry.[34] This is the reason why the U.S. wants to protect this dual-use computer technology.

In absolute terms, the U.S. spends more money on research and development than any of the other western industrialized nations. In 1983, Japan's total R & D expenditure was approximately 39 percent of the U.S. total, while West Germany

31. Ibid.
32. Ibid., p.9
33. Ibid., p.149
34. H.R. 3131. The national High Performance Computing Technology Act. Hearings before the Subcommittee on Science Research and Technology. 101st Congress. Washington, 14, 15 March 1990, p.43.

spent only 21 percent of the amount expended by the U.S.[35] Prior to 1979, the other western industrialized countries had larger increases in the average annual rate of growth of national R & D spending (with the exception of the United Kingdom in the period between 1969 and 1972) than the U.S. Since then, the U.S. had registered higher average annual rate of growth than both West Germany (a reversal of the situation in the 1970s) and the United Kingdom, although this growth rate is less than half of that experienced in Japan[36]

However, it should again be noted that increased spending for research and development does not necessarily result in parallel increases in innovation. An additional consideration in analyzing the importance of national R & D totals as an indicator of innovation or technology transfer is that raised by Harvey Brooks who found that because technology flows easily across borders, the commercialization of the results of R & D may only be ''weakly related'' to national levels of research and development.[37]

The manner in which the government spends its research and development funds has an impact on the type and extent of innovation. In the U.S., the major portion of Federal R & D money is for defence-related activities—64.3 percent in 1983. The same is true in the United Kingdom where over one half of government R & D expenditures are for defence. Both Japan and West Germany have a significantly lower portion designated for military R & D.[38] The high technology items like com-

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35. Ibid.
36. Ibid., p.27
37. Harvey Brooks, ''Technology as a Factor in U.S. Competitiveness'', in R. Scott., Bucy and George Lodge eds., U.S. Competitiveness in the World Economy. (Boston. Harvard university Press. 1985) p. 343
38. Op. Cit., P.31

puters and telecommunication equipment come within the ambit of dual-use technologies which then form the core list of dual use commerce licenses, hard to dispense, and harder to transfer.[39]

The available information shows that in Japan, government funding in this area has decreased from 4.7 percent of the total in 1975 to 2.4 percent in 1981. In West Germany, the decrease has been from 29.5 percent in 1970 to 9.4 percent in 1983. Similarly, government expenditures for defense related research and development as a percent of the total R & D funding has decreased in the United Kingdom from 72.3 percent in 1970 to 50 percent in 1983. In contrast to the declines in these countries, the United States has seen increases in government defence-related R & D as a proportion of total R & D from 52.2 percent in 1971 to 64.3 percent in 1983 (and to a larger portion through 1986). France has also shown a small increase from 32.8 percent in 1975 to 33.2 percent in 1983.[40] R & D figures with their virtual linkage with productivity and economic growth also form the basis for technology transfers.

For example, in 1983, 25 percent of U.S. government funds for industry meant to R & D in the area of electronics and 51 percent of aviation and missile development; both of which might be expected to have some influence on the scope and direction of industrial R & D activities.[41]

39. Unpublished U.S. Department of Commerce List on Dual-use Commerce Licences. Approved Applications to India p.1

40. Op. Cit., p.31

41. Ibid., p.35

Transfer of High Tech. Computers from U.S. to India: Problems and Implications:

In transfer of high technology from the U.S. to India, for the above reasons itself, the computers area became one of a competitive relationship rather than a form which it could have taken as a responsive, collaborative or adjustment mode. In the high tech. transfer arena particularly, defence and civilian sectors have just a very thin line dividing them. The duality between civil-industrial and defence-oriented becomes a matter of semantics. The Super Cray computer became a delicate matter of transfer of high-tech computers from the U.S. to India.[42]

An issue closely linked to increased Indo-US commercial cooperation lay in high-technology transfer, Substantial progress has been made in this vital area since the Indo-US signing of a Memorandum of Understanding on Technology Transfer in 1984.

In May 1987, the then U.S. Secretary of State George Schultz assured business leaders from India and the U.S. that every thing would be done on the Government side to create the environment that would allow and encourage the growth of better US-India business relations. He added that it was through ''good business'' that the US and India could get to know each other better and reinforce the existing relations.[43]

Commenting on the 1987 state of U.S.-India business, George Schultz said that

42. H R 3131 The National High Performance Computing Technology Act. Hearings Before the Subcommittee on Science. Research and Technology of the Committee on Science. Space and Technology. US House of Representatives 101 congress No. 115. 14 March 1990 US Govt., Washington. 1990. P.43

43. Press Release. American Centre. New Delhi. 13 May 1987.

the potential for further growth of the two way $ 4000 million trade was "enormous". He went on to say that as the world's two largest democracies, both countries have agreed to approach each other on a more realistic basis by identifying problems and opportunities so as to establish their relations on solid foundations.[44]

Yet, there were definite political underpinnings. The Secretary of State wanted to see more support from India on the Afghanistan issue. He was pleased to note that India and Pakistan were making efforts to solve their differences peacefully.[45]

Similar sentiments were expressed by Frank Carlucci, assistant to President Reagan for National Security Affairs, in his address to the joint US-India business Council. He said, "Let me reiterate the importance that the President attaches to our relationship with India, the efforts of Prime Minister Rajiv Gandhi for greater economic prosperity for his country and for the very constructive role that India can and, I am sure, will play for peace in the region and indeed throughout the world."[46]

According to Carlucci, the U.S. welcomed India's liberalization of its economy under Prime Minister Gandhi. "This is what attracts increasing numbers of U.S. business and contributes to an accelerated rate of economic growth", he said. He praised Prime Minister Gandhi for the "foresight to understand and encourage to tackle this issue."[47]

The U.S. is helping India in meeting its objective of technological upgradation thereby helping India to move into the 21st century, Carlucci pointed out. He said that both countries have agreed to procedures under which U.S. technology can

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44. Ibid.
45. Ibid.
46. American Newsletter, USICA (New Delhi) May 1987, p.2
47. Ibid.

be sold to India.[48]

Carlucci cited that sale of high technology to India, including General Elect..c's 244 engine for India's projected light combat aircraft and the approval of a license to sell the Cray supercomputers, XMP-1, then referred to India's expressed preference for a more advanced model and the fact that India is still deciding whether to sign the safeguards agreement required for the sale of this model.

However, he urged that India accept the sale pointing out that this was "the first time such an advanced machine has been offered to a non-COCOM country".[49]

Explaining the U.S. position on the sale of high technology, Robert Dean, Special Assistant to the President for International Programs and Technology, pointed out that "every piece of high-tech that leaves this country must be seen against the background of a global effort by the U.S. to maintain control over its technology". He assured the Indian businessmen that India was not being treated differently. He also pointed out that since the threshold of computer technology in the U.S. was moving up so rapidly, the U.S. would be able to collaborate with India at a higher level of supercomputer technology in the future.[50]

Considering these positive statements on the U.S.-India technology transfer in computers, the closeness of Indo-former USSR relations was perhaps the factor that led the U.S. to withhold rapid transfer of the computer. With the changing international political environment, this ought no longer to be the case.

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48. Ibid.
49. Ibid.
50. Ibid.

During the same year the Working Group of the U.S.-India Joint Business Council on Technology Transfer agreed that technology transfer was the chief vehicle for doing business in India; India's manufacturing sector was seeking those technologies not available in India, and the realities of limited foreign exchange resources and the need to maximize their utilization are to be appreciated. The discussions were frank and open with both agreement and differences. The Americans did recognise the size of the Indian market and its potential but deplored rigidity of Indian procedures, while the Indians thought the U.S. export licensing procedures onerous, cumbersome and inconsistent. Both Indian and American businessmen felt that they ought to systematically brief their respective governments on the advantages of liberalization, delicensing and deregulation.[51]

The truth is that since India's policy is dictated by a basic concern for the most effective utilization of the country's limited foreign exchange reserves, the involvement of the Govternment of India was inescapable. The U.S. companies have minimal interference by the U.S. Govt., yet there is upto 1 per cent holding back on high-tech items by the U.S. Govt. for reasons of protecting its defense interests.[52] Therefore, in the case of transfer of high technology, both governments and private industries are inextricably involved. Further, licensing, patents, royalty fees, and anti-trust laws are major issues which have to be negotiated carefully.

It is to the credit of the U.S. that since the memorandum of understanding signed n 1984, the U.S. has been working hard to speed up export licensing decisions ınd raise the level of sophistication of the technology that it will export to India.

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51. U.S.-India Business Leaders Conference. 11-13 May 1987. (Washington D.C.) Report. FICCI.
52. Interview with Dr. Peter Heydemann. U.S. Science Counsellor to India. 1 February 1991.

For its part, India upto an extent and degree has been able to reassure the US that sensitive technology will be safeguarded. The approvals of a supercomputer for Indian monsoon research and weather forecasting and several high-tech items in the area of Indo-U.S. defence cooperation are clear indications that real progress has been made in the field of technology transfer.[53]

The export licence data of the U.S. Department of Commerce certainly support the conclusion that the U.S. is more responsive to Indian requests than before, e.g., the volume of approved licenses dealing with civilian and military technology increased more than 400 per cent from 1983-87. In 1983, 710 licenses worth 227 million dollars were approved. In 1987, 3916 licenses worth more than 563 million dollars were approved.[54]

The ratio of approvals to applications also has improved considerably. In 1983, for example, 80 percent of the 891 requests received were approved. In 1987, 94 percent of 4184 requests received were approved.[55]

The time it takes to process licence applications has also been greatly reduced. In 1983, an average application took 92 days to move through the system. By 1987, the same application would be acted upon in only 41 days.[56]

Table-1 indicates the foreign collaborations approved by The Government of India during 1982-1991.[57]

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53. Official Text. USICA. New Delhi. 29 April 1988., p.10.
54. Ibid.
55. Ibid.
56. Ibid.
57. FICCI. Working paper on Indo-US Trade. 1991. p.11.

TABLE 1

FOREIGN COLLABORATIONS

The following tables indicates the foreign collaborations approved by Government of India during 1982-1990

COUNTRY	TECHNICAL	FINANCIAL	TOTAL	PERCENTAGE SHARE %
	(1)	(2)	(3)	(4)
USA	993	433	1426	18.86
FRG	1004	300	1304	19.07
UK	843	208	1051	16.01
JAPAN	583	98	681	11.08
ITALY	311	87	398	5.91
FRANCE	283	70	353	5.38
SWITZERLAND	253	67	320	4.81
SWEDEN	127	38	165	2.41
NETHERLANDS	111	35	146	2.11
TOTAL	5264	1782	7046	100

- Out of a total of 7046 agreements approved, USA accounted for 1426 i.e. about 19 per cent.

- Out of a total of 1426 Indo-US collaborations, 993 agreements were purely technical in nature with the remaining involving investment as well as technology transfer.

Over the recent past, most of the collaborations have been in areas such as electronics, petrochemicals, instrumentation, engineering and chemicals.

Status of Technology:

Computer technology is highly fast paced and complex. It is unlikely that the industrialised countries would transfer the latest model of a supercomputer to any country that is not a military ally. Attempts by a developing country to acquire the latest version usually result in long drawn negotiations with predictable results.[58]

An example of this is provided by negotiations between India and the USA for the purchase of a supercomputer by India.[59]

This is a major case illustrating the transfer of U.S. computer technology to India. In order to strengthen relations between the two-countries, President Reagan and Prime Minister Rajiv Gandhi signed a General Agreement on High Technology in 1985. This Agreement cleared the way for the transfer of many dual-use items to India, including a radar system and six minicomputers. India also expressed a desire to purchase a supercomputer for weather forecasting, and modelling of the critical monsoons that bring the much needed rain to most of its parts. The USA was initially unenthusiastic about such a sale, for it had never approved the sale of a supercomputer to any country outside the ''Western Alliance''.[60]

The following headlines from some U.S. news papers reveal the trends of negotiations between the two countries: U.S. Said to Balk at Sale of a Computer to India.[61]

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58. Toufiq. A. Siddiqi. ''Factors influencing the Transfer of High Technology to the Developing Countries'' in Manas Chatterji, ed., Technology Transfer in the Developing countries, (London: Macmillan, 1990) p.159.

59. Ibid.

60. Ibid.

61. Sanjoy Hazarika, New York Times, 16 June 1985.

U.S.-India Accord on Computer sale.[62]

Hope Fades for US Technology Sales to India.[63]

In a compromise, India will buy smaller supercomputer from U.S.[64]

The first of these headlines refers to the U.S. administration's decision to turn down the Indian request for an advanced supercomputer. The Pentagon officials were concerned about the possible use of the supercomputer for nuclear research, since India is not a signatory to the nuclear Non-Proliferation Treaty. There was also some concern about possible former Soviet access to the supercomputer, in view of India's close ties with the former U.S.S.R. But another official of the U.S. Administration had observed India would get the supercomputer at a future date.[65]

The negotiations over the year (1986) reflected the progress. but these same negotiations, became extremely sensitive and came frequently close to a breaking point.

Washington initially suggested that India permit inspection by outside officials to ensure that the computer would not be put to unauthorised use. India refused, arguing that such an arrangement would breach its sovereignty. The talks were delayed early in 1986 when India, impatient over the lack of progress, said it would begin discussions with Japan to purchase a Japanese supercomputer. The USA then worked out an arrangement with Japan, under which the two countries would insist on the same guarantees. Details of the safeguards that were finally worked out have

62. Steven. R. Weisman. New York Times.11 Dec. 1986.

63. Carrington. and Robert S.Greenberger. Asian Wall Street Journal. 15 June 1987.

64. Steven R. Weisman. New York Times. 9 October 1987.

65. n.57. p.159.

not been made public.[66]

In June 1987, the situation deteriorated again. There were accusations by the Indian side that the USA had raised the level of expectations, and then reneged. It was alleged that the U.S. side had allowed the Indian side to assume that they could purchase the XMP-24 supercomputer, which has a dual processor, and is manufactured by Cray Research Inc., but were finally offering the less powerful Cray XMP-14, a single processor unit costing about 20 million dollar. Pentagon officials said that they had never been willing to permit sale of the XMP-24. Some U.S. officials believed that the computer incident was caught up in domestic Indian politics.[67]

An agreement was reached shortly before Prime Minister Rajiv Gandhi was to visit Washington. India would purchase an XMP-14, with the understanding that it could be upgraded in the future. A major concern of the U.S. Department of Defense had always been that the computer might be used for the development of nuclear weapons.[68]Others were worried about India's close links with the former Soviet Union, and the possibility of the Soviets obtaining access to the computer, which could enable them to decode U.S. military communications. Safeguards acceptable to both sides were worked out as part of the agreement. Again, details thereof have not yet been made public.[69]

The sale of this U.S. computer to India provides a fascinating example of al-

66. Ibid., p.160
67. Carrington and Greenberger, 1987.
68. Steven Weisman, "US-India Accord on Computer Sale" New York Times, 9 October 1987.
69. Siddiqi, p.160

most all the obstacles one is likely to encounter in the transfer of high technology—political relationships involving the then superpowers, a desire for the very latest generation of technology rather than one that might be a few years old, differing views among parts of the bureaucracy in both countries, and compulsions of domestic politics. If the arrangements that were finally worked out are successful, they could serve as precedent for additional transfers of high technology, not only to India, but also to a number of other LDCs as well.[70]

Workshop on Technology Transfer:

A manifestation of Indo-U.S. cooperation was brought out by the Indo-U.S. Joint Business Council, 3-4 November 1988, in New Delhi. The 52 member U.S. Delegation was led by Mr. Donald M. Kendall. The two sides discussed the possibilities of cooperation in areas such as electronics, computers, telecommunications, etc. Issues related to trade and technology transfer were vital in the discussions. Senior officials from the concerned ministries, Reserve Bank of India-and General Insurance Corporation of India participated in the workshop.[71]

A workshop on Technology Transfer was organised at the same meeting under the Chairmanship of Mr. A.V. Ganesan, Additional Secretary, Department of Industrial Development.[72]

Senator Charles Percy, Chairman, Technology Transfer Committee, U.S. Section, observed that the two sides had set up a Task Force last year to examine the con-

70. Ibid. p.160-1.

71. U.S.-India Bilateral Business Conference Report. Indo-U.S. Joint Business Council, 3-4 Nov. 1988, p.3

72. Ibid.

straints coming in the way of promoting technology transfer between the U.S. and India.

Certain issues remained unresolved, nonetheless. Senator Percy urged the Indian side to make continuous efforts for the implementation of the decisions taken at the previous meeting of the Task Force on Technology Transfer held in March 1988.[73]

The U.S. has emerged as India's largest trading partner but there is scope for much higher levels of trade.[74] In 1987, the two-way trade touched $4 billion recording an increase of 5 percent over the previous year.[75] There has been considerable expansion in bilateral trade ever since. With the new matrix of exchange rates, there should be a change in the pattern of sharing as well. In India's Eighth Five Year Plan (1990-95), the private sector was being assigned a larger role. Private foreign investment was also expected to contribute more in India's developmental efforts. Out of the total private corporate sector investment of Rs. 1.5 trillion ($50 billion), foreign investment might be around Rs. 220 billion ($ 7.3 billion).[76]

A marked asymmetry thus characterises Indo-US political economic relations. All this notwithstanding, the USA is India's largest trading partner e.g. in 1986-87 exports to the US accounted for nearly 18.6 percent of total Indian exports and more than 10 percent of India's total imports. (See Table 2).[77]

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73. Ibid.
74. Ibid., p.4
75. Ibid.
76. Ibid.,
77. US Bureau of Census in Rajiv Kumar Indo-US Relations. The Economic Context. IDSA. 24 February 1988. p.14.

TABLE 2

Indo-U.S. Trade
(U.S. $ million)

YEAR	US EXPORTS TO INDIA	US IMPORTS FROM INDIA	TOTAL TRADE	BALANCE OF TRADE
1975	1,289.7	548.2	1,837.0	-741.5
1976	1,135.8	708.2	1,844.0	-427.6
1977	778.6	781.1	1,559.7	2.5
1978	947.9	979.5	1,927.4	31.6
1979	1,167.0	1,037.7	2,204.7	-129.3
1980	1,689.4	1,097.6	2,787.0	-591.8
1981	1,747.5	1,202.1	2,949.6	-545.4
1982	1,598.5	1,403.8	3,002.3	-194.7
1983	1,827.8	2,191.4	4,019.2	363.6
1984	1,569.6	2,551.5	4,121.1	981.9
1985	1,641.9	2,478.3	4,120.2	836.4
1986	1,536.0	2,464.6	4,000.6	928.6
1987 (Jan.-Oct)	1,172.0	2,302.6		

Source: US Bureau of Census

The US was also the leading source for foreign collaborations with Indian firms. (Table 3). Even for financial inflows into India, both concessional and commercial,

TABLE 3

Indo-U.S. Collaboration Cases*

YEAR	TOTAL COLLABORATIONS ALL COUNTRIES	TOTAL	PERCENTAGE SHARE	FINANCIAL TECHNICAL CUM FINANCIAL	TECHNICAL
1980	526	125	23.8	19	106
1981	389	85	21.9	15	70
1982	590	110	18.6	24	86
1983	673	135	20.1	32	103
1984	752	147	19.5	36	111
1985	1024	197	19.2	66	131
1986	957	189	19.7	71	118

*Source: Indian Investment Centre

the US was the predominant supplier specially when US contributors to multilateral financial flows to India are included.[78] The US, clearly, is one of the most important, if not the most important economic partner for India. Viewed from the US angle, Indian exports to the US accounted for barely 0.62 percent of total US imports of 387.08 billion in 1986. India's share was a mere 0.7 percent in global exports of $ 213.1 billion from the US. Despite an upward trend in the past few years (reportedly, US investment in India during 1985 and 1986 was more than the total invested in a decade prior to that) direct investment of US firms in India was less than1% of capital investment globally. Yet for India, this represented nearly a third of direct investment inflows. India manifestly, is of marginal concern to US economic activity.[79] It is an Indian concern to be somewhat more and to cooperate much more. Through India's record as a technology receiver had been exemplary, it was still grouped with countries at the lowest level of export privileges on account of export licensing controls in the U.S.[80]

To bridge the asymmetrical gap, India's liberalization procedures have helped but marginally. India will have to do much more to gain technological acquisitions in the area of computers, telecommunications etc.[81]

In particular, there were too many barriers and lack of clarity on the government of India's licensing and technology transfer policies. The US side had also shown concern over the inconsistencies in implementation of technology transfer

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78. Ibid.

79. Ibid., p.1.

80. U.S. Export Controls: Regulations and Procedures. Annexure 'A' Indo-USA March 1990. p.2. IACC.

81. Indo-US Joint Business Council Report. 1988. p.5.

agreements. India needed high technology, particularly to generate employment for its technical manpower.[82]

Responding to the points made in the Technology Transfer workshop, Mr. Ganesan agreed with the view that business decisions should be left to the forces of market mechanism. However, while decisions at the micro level should be left to individuals, macro decisions had to be made by the Government. But, wherever such controls were necessary, policies and procedures were being simplified. Entrepreneurs would not get involved unnecessarily in bureaucratic delays. Accordingly, unnecessary and unproductive controls were being removed so that there was minimum need for business to seek prior approvals.[83]

US was India's leading industrial partner. Twentyfive to thirty percent of the technology transfer arrangements concluded by India were with U.S. The US share in India's foreign investment was also increasing. However, there was tremendous potential for increasing joint ventures and cooperation between the two countries that were mutually beneficial to both sides. This was feasible since India fulfilled the basic requirements of foreign investors. These included a stable and congenial business climate, capable joint venture partners, availability of technical manpower, strong capital market and rich natural resource endowment.[84]

There were problems over the terms of royalty payment (the US felt the Indian government should do away with the ceiling of 5 percent on royalty payments and 8 percent in case of lumpsum payments)[85], reduce delays for approval of li-

82. Ibid., p.7
83. Ibid., p.8.
84. Ibid., p.9.
85. Ibid., p.10.

censes (it took only six weeks in Thailand while in India it took nearly 6 to 18 months to get proposals cleared). Reducing delays should be a major concern as the time factor makes technologies obsolete.[86]

In 1988, a number of policy relaxations were announced and further liberalisation measures being in the pipeline, hinted at. Regarding foreign equity participation, the Indian Government's policy would continue to be the same because presently more than 40 percent equity participation was being allowed in high-tech areas, which would go upto 100 percent in case of export oriented units.[87] Therefore, it seems logical that most computers technology transfer from the US to India is done through private firms and by joint ventures.

One joint venture looked into as an appropriate case study showed a positive profile. Hinditron, India and DEC, USA promoted Digital Equipment (India) Limited. This company has an equity base of Rs. 250 million. Digital Equipment Corporation, USA, holds 40 percent equity and Hinditron holds 30 percent equity. Digital Equipment (India) Limited has invested around Rs. 150 million (only $5 million) to set up one of India's most sophisticated computer manufacturing facilities for Digital's products at Bangalore.[88]

Where the Hinditron services profile goes, over the last decade, the Communications and Aerospace Division has played a vital role in providing state-of-the art technologies and equipment to the Indian market. It caters to the requirements of communications, space, defence electronics etc. It markets and services equipment, sub-systems and components for these industry categories. This Division has

86. Ibid., p.11.

87. Ibid., P.12

88. Hinditron profile. (Bangalore. 1989) p.1

a turnover of Rs. 60 million (US $2 million) and offers a wide range of products and services. It has a highly qualified and comprehensively trained workforce with relevant specialization. Its network of sales and customer support service centres covers 8 major metropolitan cities. It also represents seven internationally reputed companies.[89]

Amongst other things, Hinditron's computers, over the last 18 years, have played a key role in introducing innovative products and technologies to the Indian computing environment. The activity of this group has a turnover of Rs. 600 million (US $ 20 million) and offers a wide range of products and services. The group has a work force of 500 professionals, many of them trained in USA, UK and West Germany. It has an R & D centre for hardware and software development recognised by the Department of Science and Technology, New Delhi. It represents over 25 leading international companies offering advanced computer related products and services.[90]

Hinditron has one of the largest installed bases of computer systems. Major customers include defence, space research, scientific and educational institution s, and many prestigious business and industrial organisations. It also has a nation-wide network of sales and customer support service centres which cover 38 locations. It also has over 200 man-years of software development and services exported to USA, Australia, UK, West Germany, and other European countries.[91] Other areas of operation cover:

-PC and special systems;

89. Ibid., p.2
90. Ibid., p.6
91. Ibid.

-Network and communication products;

-Advanced Technology products;

-CAD/CAM/CAE;

-Process Control and Automation Systems;

-Simulation and control systems software

-Software products;

-Turnkey software projects—international; and

-Turnkey software projects—national.[92]

It is in the same sense of continuous transfer of computer technology that the Lotus comes to India. It is a leading U.S. software company with ventures all over the world, marketing its products in 65 countries. The software Lotus 1-2-3 is part and parcel of an overwhelming majority of computerised business operations in India. The company has launched close to 50 products, including Free-lance Plus (a graphics package), Agenda (claimed to create a new category of information management software), the new Symphony (which combines spread sheets, work processing, graphics, data base, communications and publishing—all in one 'easy to use' format) and Lotus one source (the computer industry's only CD-ROM family of products).[93]

More recently, Lotus sales in the US are reported to have stagnated and the company is now concentrating on the international market. Sales outside the US accounted for 42 percent of its total turnover of $ 556 millions in 1989. According to Mr. MacDonald, Director, there was to be more marketing and distribution computer

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92. Ibid.

93. Computers Today, (New Delhi) vol.6, no.63, May 1990, p.5

software in India.[94]

Transfer of computer technology through firms or joint ventures is not merely one-sided with the benefits accruing only to the 'receiver' nation; of the 'giver' nation also gains.

Implications of India's Imports-Exports Computer Policy:

It is with this concept of interdependence in the agenda, no doubt an asymmetrical one at the moment but with a desire to balance this in the future that both India's policies to import (by regulation, easier licensing procedures) and export computers via (higher productivity, policies and strategies) computers have been undertaken. The import export computer software policies are inextricably linked.

Among the condition s of imports are: the foreign exchange requirement for the import of computer system shall be met through the allocations from the union government. A legal bond or undertaking will be executed by the party with the chief controller of imports and exports (CCI and E) for an export obligation equal to 350 percent of the c.i.f. value of the system.[95]

The load or undertaking was to include a provision that the party will undertake to effect the following minimum levels software export (by value) over the four years duration of the export obligation.[96] Fulfilment of the export obligations will be met by the net foreign exchange earned, which is defined as foreign exchange inflows as a result of software export less foreign exchange outflows on account of expenditure other than initial hardware and/or software import. The export obliga-

94. Ibid.
95. Times of India, 4 July 1989.
96. Ibid.

tion will start from the date on which custom clearance for the first consignment of imports is obtained.[97]

A further amendment of the scheme was made by the Government. of India in 1989 for the import of computer hardware under software export scheme. This is being done by reducing the export obligation and custom duty for computers making use of the scheme. The importers will now have a 300 percent gross export obligations in place of 300 percent net, which has been the case till now. The import duty, to be paid has also been brought down from 35 percent to 25 percent.[98]

This is another step towards achieving the software export target of US $ 400 million by September 1991. During 1989-90, India exported software worth Rs. 175 crores. To enhance software export, schemes to set up software technology parks have been undertaken. The units under the Software Technology Parks (STP) scheme are to be 100 percent export oriented.[99] There have been four such STP established at Trivandrum, Pune, Bangalore, and Noida but there are lags in establishing a good datacom link.

In fact, prior to this, the then Indian Union Commerce Minister, Mr. Arun Nehru had assured that while eliminating unnecessary imports, the government would ensure that those having a direct bearing on exports are not curtailed. Emphasizing the need to export especially in the wake of the growing movement towards free trade regimes, he said that marketing should be intensified and that ''India is no

97. Ibid.

98. Times of India. 8 December 1990.

99. Ibid.

longer merely an exporter of commodities but is diversifying rapidly as a manufacturer and exporter of value-added products and high technology''.[100] He also stressed that there would be no compromise on the basic objectives of deregulating controls. ''Exports can grow if the process of deregulation is continued so as to allow industries to keep pace with global trends in different sectors'', he added.[101]

Hence, India's computer software import policy became inextricably linked with export policy. No doubt there are tremendous lags—inadequacy of communication links, ambitious targetting and the STPs under-utilized because of lack of infrastructure and finances, but with effort these can be overcome. India is slated to lead in software by 90s.[102]

Indian experts at a Washington workshop estimated that as against the $50 billion world trade predicted for software by 1990, India is expected to export software worth Rs.300 crores by this period. It was described as ''a modest target, no doubt'', but they emphasised it was a market poised for growth.[103] In his keynote address, Mr. K.P.P. Nambiar, Secretary of the Indian Government, Department of Electronics said that India is demonstrating consistently growth rates of about 35 to 40 percent per annum for its electronic industry in recent years. It will be able to produce about $80 billion worth of electronic products by the turn of the century even if the rate of growth goes down to the level of 25 percent. Import of technology and foreign collaborations were welcomed in all areas of electronics. Over 750 foreign

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100. Times of India, 29 July 1990.

101. Ibid.

102. Interview with Rear Admiral K. Ramanarasiah, Director, Technology Development Centre, Ministry of Defence, Bangalore, 20 June 1991.

103. Ibid.

collaborations with the USA, UK, Japan, West Germany, France, Switzerland, Sweden and other countries had been cleared since 1975 for importing electronics and computers software. The US was by far the largest partner in collaboration.[104]

In less than a decade, India's computer software industry has grown to a position of strength and status in the international market place of computer technology.[105] Regardless of the import policy of computer software, which is getting more rationalised, India is a virtual non-player in the US software market because of: (1) High cost of development and marketing involving high risk and, of course, high gains; (2) Lack of anticipation and innovation by Indian software developers; and (3) High packaging and after-sales service costs.[106]

On the other hand, the computer industry in India has grown both in terms of physical output as well as range of product introduced in the market. The compound growth in monetary terms during last five years has been about 50 percent. The indigenous production of computers and related items in 1988-89 has increased to Rs.560 crores (about $187 million) from a level of Rs.424 crores in 1987-1988. The production of computers in 1984-85 was only Rs.95 crores. The majority of production is accounted by PCS, PC/ATS and mini systems (based on 80386 microprocessors), and most of the demand for computer peripherals is being met through local production.[107]

Application of computers in service sectors has already begun in India. Com-

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104. Ibid.

105. Ibid.

106. "The US Market for Indian Software Exports. July 1990". Consulate General of India. San Francisco.

107. India's Electronics Exports Council Report on Software Export: An Overview 1990. (New Delhi) p.9.

puterization in Indian Railways and in banks has started. Replication is also relatively easy and cost effective since the systems are based on indigenous R & D. RBI is planning to set up a BANKNET to further improve their productivity.[108]

Looking at future computer systems, National Information Council Network (NICNET), completed in 1990, links 450 district headquarters, 32 state/union territory capitals and the national capital. This facility vertically and horizontally integrates the Indian government at the central and state levels as well as the district administrations. The date bases are spread over a lot of areas-industry, transport, civil supplies etc.[109]

The US has definitely contributed to this development by transferring computer technologies but a whole cluster of new technologies are emerging in computer software:

-Groupware; natural language; irregular information retrieval; multimedia; voice mail; aggregate software; and prefabricated software.[110]

While there is no immediate threat over the years these developments could substantially neutralize the cost advantage enjoyed by India, vis-a-vis the U.S., particularly at the lower end of the programming tasks.[111]

The worldwide software technology today is characterized by a new trend; simultaneous collaboration and competition. Dominant as they are already, the multinational companies influence in three ways the pattern of growth of the industry

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108. Ibid.

109. N. Seshagiri, "NICSAT: Design Bases of a Low Cost Ka-Band Data Communication Micro Satellite with OBP for Block Level VSAT Network" in Proceedings of the 10th International Conference on Computer Communication, (New Delhi), 1990.

110. The U.S. Market for Indian Software Exports, San Francisco, July 1990, p.10.

111. Ibid.

in the developing countries.[112]

Firstly, computer software systems are growing rapidly all over the world. Secondly, human ingenuity, skill and innovative capacities, seem to be almost limitless and indeed fusing freely internationally. And thirdly, the interactive processes amongst numerous companies—along commercial and trade circuits—are so complex and intertwining that at no given time is it either unilinear or absolutely stationary. In other words, interfacing processes in the systems are in continual flux. The dynamics in the international software area is, consequently multipolar, inter-disciplinary, integrative and therefore highly competitive. For India's industry not to appreciate this compelling situation is to invite stagnation and gradual mortification.[113]

Given the global canvas, the Indian software industry is not only relatively new but also small. Nevertheless, over the years, the number of firms—large, medium, and small—is growing. In a recent study, it is revealed that there are nearly 360 software companies in the country. Also another 250 firms are engaged in processing data and function primarily as consultancy agencies. Still another category of 20 software system organisations seems to have sisterly relations with hardware suppliers. Thus, it is obvious—as compared to a situation, say in 1984, when the Government of India licensed only 120 companies for software production—that the country's development in the field is moving rapidly.[114]

And yet, a look away from the mere numbers gives a different facet of the industry that is the structure of it. India's software industry is extremely concentrated

112. Probhat Roy. "High-Tech Whirlpool India's Change". Telematics India. (New Delhi) March 1991. p.67

113. Ibid.

114. Ibid.

and evident from the fact that the top three firms each garner business worth over $10 million in software products and services; the remaining vast majority of companies produce as little as $1 million or even less. The revenue earnings of these firms—almost 75 percent of the total in 1986-87—totalled less than $100,000. This means Indian companies are small independent entities having little or no financial muscle to expand and no real capital support as they are not part of any big business or financial conglomerate. On this narrow support base, the Indian software industry survives.[115]

One of the reasons for the survival of the Indian software industry is a marked tendency to coalesce and to collaborate with firms across national boundaries. In an interdependent world of trade, commerce and international politics, firms of status and stability are engaging themselves increasingly in adjunctive activities—both within the nations and amongst nations—primarily for the purposes of export. That shows not merely a moment of commonality of interests but also a sense of maturity amongst some of the firms, in the so-called Third World countries. India is, of course, no exception to this emerging phenomenon.

The worldwide software industry is still what is fancifully called industries nouveau. Once the exclusive domain of the United States, and later, of France and Japan, the software industry is spreading its net far and wide. The depth and dimensions of the industry as well as the volume and the variety of its products are truly extraordinary. Although data are somewhat inadequate, it is calculated that the world market for software on an average is increasing at the rate of 20 to 30 percent

115. Ibid.

annually. It is likely to touch $100-$120 billion in 1990. It is projected to expand to $340 billion by 1996. Such is the rapid pacing and forceful nature of the industry.[116]

The global software industry is in the vortex of a vital restructuring and consolidation process. The process, incidentally, is responding to the technological revolution that is altering the ongoing method of software production with the concomitant differentiation in hardware telecommunication. Recently, two firms have been prime examples of this. Texas Instruments and Citicorp have established subsidiaries for export. The reverse directional movement is no less significant. Hindustan Computers Limited has floated HCL America. Others like Patni Computers and Hinditron have graduated into joint venture partnerships, Patni with Data General and Hinditron with Digital Equipment.[117]

Therefore, U.S. technological transfers have risen and have been successful even despite regulatory controls in computers. There have been implicit technological transfers via technical training of manpower and linking with university research centres. There have been concrete technological computer transfers from firm to firm and in the form of joint ventures. There are controls which have to be analysed on the Indian and the U.S. side and minimized to make technological giving and technological receiving more feasible. On balance, India must liberalize its policies as well as make them less restrictive to make a much bigger dent on the U.S. market.

The U.S. needs to review its policies and loosen up on subjects like intellectual property rights to be able to treat India both as a business partner and politi-

116. Ibid.

117. Ibid.

cal ally.[118] Changes in political policies underline changes on the part of both U.S. and India's attitudes towards each other.

Transfer of Computer Technology from FRG

In the past few years, the software market in the FRG developed a dynamism matched by no other German sector of industry. With growth rates, which in the past five years, almost invariably lay between more than 15 and 20 percent, development energies have been released and will continue to be operative in the next few years, given the vast, still unused applications potential. Both in the standard software and in the applications-specific software business, new market segments and niches present themselves to new businesses coming up in the market, the assumption being that standard software will grow at a faster pace in the next few years.[119]

The fact that at present around 2,500 firms in the FRG achieve a software turnover of some 15 to 16 billion Deutschmarks a year, clearly illustrates the important role software plays in the entire industry of Western Europe. By far the biggest share in software turnover continues to be taken by big user-specific solutions for large-scale computer systems, also in the area of hardware manufacture. But, no doubt, the growth potentials are in standard software for small and medium sized computer systems, especially work stations within an interlinked centralised systems structures, but also in autonomous computer systems. Hardware manufactures continue to be the leaders in the software market. Next comes the mere software manufacturers

118. Hearing Before the Subcommittee on Science, Research and Technology, Copyright Protection for Intellectual Property to Enhance Technology Transfer, 101st Congress, 1991, p.85

119. Indo-German Export Promotion Project Market Report, 23, Computer Software, February 1989, p.7.

in close liaison with the system houses.[120]

In the FRG, as in the whole of Europe, this is marred by the lack of software engineers and steadily increasing costs. Information experts are 4,000 short, with an average demand situation of 8,000.[121] This becomes a focal point of partnership with India.

In a variety of conceivable cooperation possibilities, the following possibilities of cooperation are seen: import of software from India; joint ventures with Indian software firms and marketing of ''Made-in-India'' software packages by German companies as well as subcontracting of programming; joint serving of the world market with India supplying the software and Germany the hardware and cooperation with German companies regarding in-house production.[122]

One of the main tasks must be to develop in the FRG an awareness of existing capabilities and gained experiences of Indian software firms with the aim that software development in cooperation with Indian firms is looked at as being cost effective and free from risks. This is a prerequisite for any further success in winning acceptance on the German side. In addition to the already existing trend towards internationalization of the software market, the completion of the internal European market in 1992 forces the presently more domestic oriented German industry to think in terms of international competitiveness. The foreseeable growth potential of this market will offer huge opportunities for reliable Indian software companies to enter the market through competition.

120. Ibid.

121. Ibid.

122. Ibid.p.8

In the past 15 years, structural changes have taken place on the German Electronic Data Processing (EDP) market, as a result of which the software market has emerged as an independent force governed by laws of its own. Software development and all the activities related to it are labour—and knowledge—intensive, with manpower that is highly qualified, scarce and, therefore, expensive. Software development offers considerable potential for rationalisation. Software engineering, new languages, and new methods and tools will make software development less labour-intensive, even if "assembly line" production of software is not yet possible. Moreover, simpler-languages will result in some of the programming being shifted into the sphere of the end user. It is difficult to estimate what impact these developments will have on the growth of the software market. It is possible that by pursuing them, the software developers may be limiting their own prospects for the future.[123]

At the moment, however, the situation on the software market is characterised by quite different problems, which must be seen in the context of the "software bottleneck". The reason for this is that owing to the pace of technological development on the hardware front, it has not been possible to exploit the applications potential of the devices from a software point of view.

It is by no means easy to estimate the exact volume of the market for software and services; since no official statistics are produced purely for the software industry, one has to rely on the estimates of market research companies, associations and individual suppliers.

There are substantial discrepancies between the available figures. This is due to the fact that it is hard to figure out the volume of the user-produced or in-house

123. Lothar Hack "Frankreichs Industrie-politik im Shannungsfeld Aussen politischer und gesselshaftlicher Interessen in 1992 Jahrbuch Arbeit und Technik. (Bonn: Verlay 1992). p.144

software developed by big companies, banks or public enterprises (Deutsche Bundesbahn, Lufthansa) for their own purposes.

Despite these differences, all statistics show a dynamic development of the German software market in recent years. In absolute terms, the 1987 turnover of hardware, software and services had a total volume of approximately 40 billion DM, with average growth rates of 11 per cent. The German software market is calculated at some 18.6 billion DM in 1987. For 1988, DM21 billion are prognosticated, with an estimate for 1990 set on 30.4 billion DM with an annual growth of about 16 percent.[124]

Regarding the market volume, it must be kept in mind that the software turnover contains expenditures for-service, such as consultancy training, maintenance etc. Service accounts for about half of the total turnover, putting the straight software turnover at approximately 9.5 billion DM.[125]

Fig.2

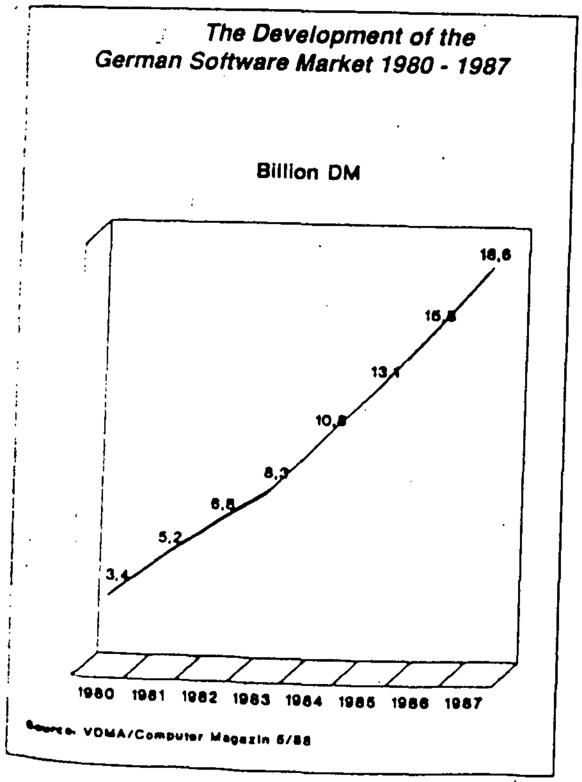
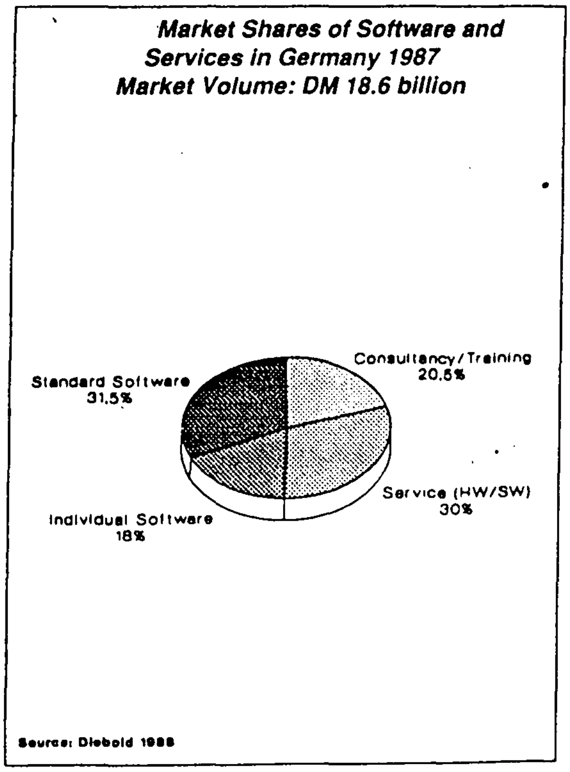


Fig.3



124. Op.cit. p.11.

125. Ibid.

The booming situation in the seventies stabilized during the 1980s, still showing a two digit growth rate in computers. Growth impulses for the German information technology in communication industry, as against the U.S. or Japan, will be released by the standardization of operating systems or network technologies highly favoured by Europe and the development and realisation of the ISDN technique. Furthermore, Germans and Europeans are traditionally end-user oriented as are the Americans and offer solutions emphasizing consultancy, service and support, helping Europe to gain a competitive edge one the U.S. and Japan.

The term ''standard software'' should only apply to programmes that are created as a product with the aim of making multiple sales. This definition fits only a small number of the programmes sold by German suppliers, who generally use the term standard software to include programmes originally developed for an individual customer but subsequently sold to others with only minor modifications.[126]

In 1983, only 20 percent of standard applications was developed as a product for the German market, whereas 80 percent was the result of individual bespoke development work that firms hoped to be able to sell to other customers as well.

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126. Ibid., p.13

Fig. 4

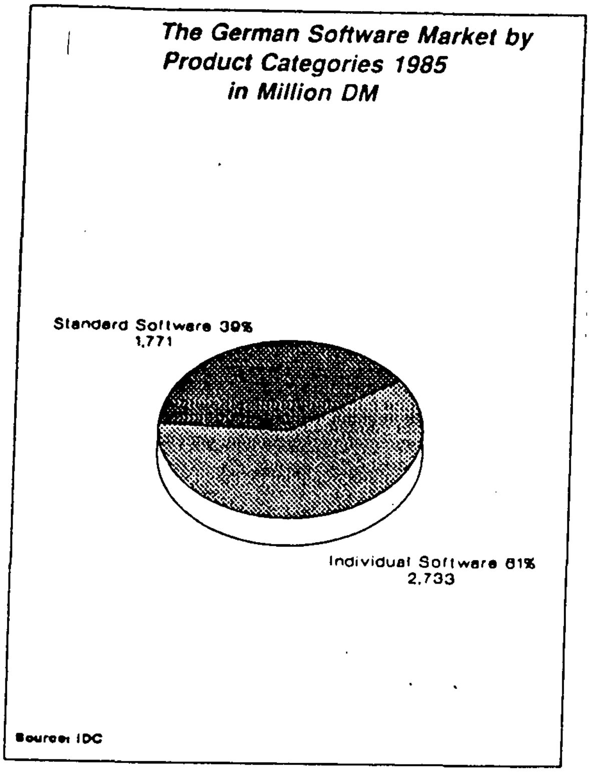
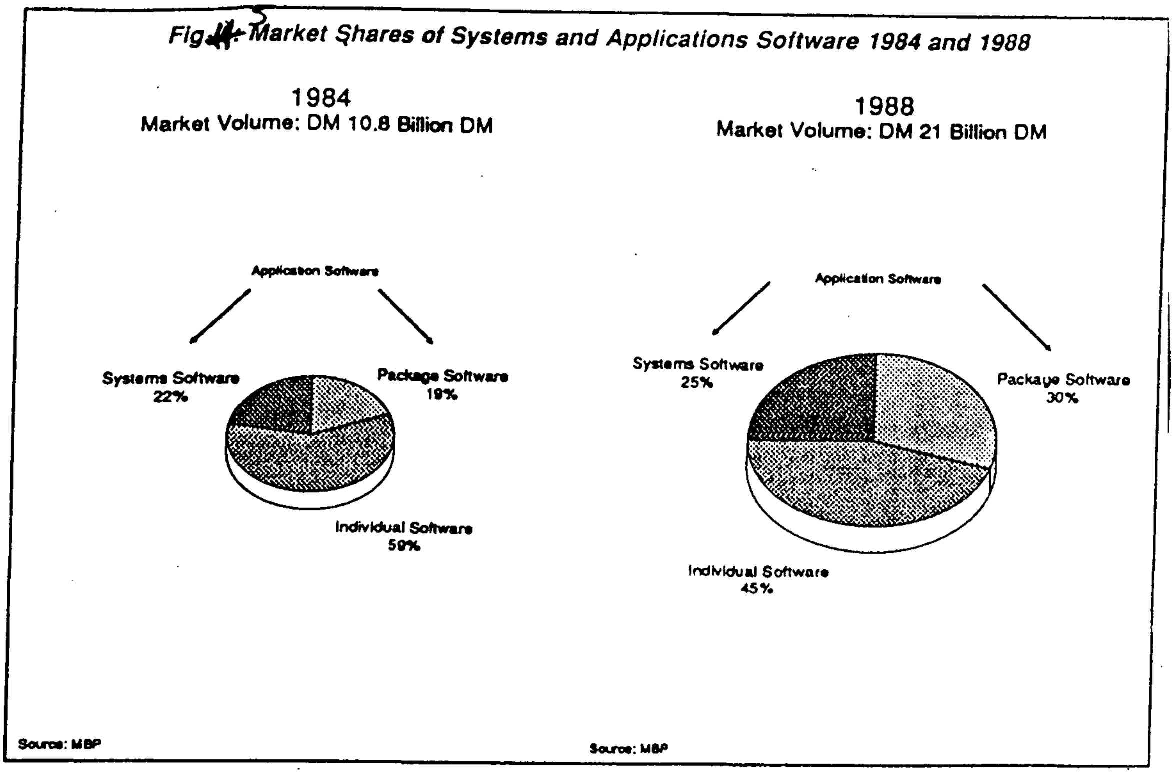


Fig. 4 shows the split between individual and standard software on the German market in 1985. A comparison with the previous years, figures reveals the growing proportion of standard software. This trend was maintained from 1984 to 1988. The main growth market is in the field of applications packages, while the share of system-related and systems software, mostly sold as standard software, will probably stagnate.

Fig.5 indicates the trend towards application packages already described and the corresponding move away from individual software.[127]

127. Ibid. p. 14.

Fig.5



manufacturer's strong point, it is the main focus of attention for system houses and independent suppliers. The bulk of the software developed by hardware manufacturers is systems software.[128]

The software suppliers are establishing user programmes for data and information processing for many sectors of economy, mainly in the frame of rationalisation projects. The target groups are trade (especially wholesale), services (insurance and banking), public administration as also manufacturing and industry (i.e. in the secondary and tertiary sector).[129]

128. Ibid.

129. J.L. Enos. The Creation of Technological capability in Developing Countries (London: Printer. 1991) p.58-59

Fig. 6

Market Shares of Various Supplier Categories on the Individual and Standard Software Market 1984

	Standard Software		Individual Software		Total	
	mill. DM	%	mill. DM	%	mill. DM	%
Hardware Manufacturers	1.164	33	327	9	1.491	42
System Houses	238	7	304	9	542	15
Independent Suppliers	652	16	870	24	1.522	43
Total	2.054	58	1501	42	4.504	100

Source IDC

Apart from a central data and information processing, user solutions are offered for medium sized and large companies, as well as communication software for all fields and individual organisation software, depending on the requirements of the individual customers. Moreover, package solutions for software and hardware are proposed for certain industries.[130]

The following categories of user software dominate the programme range: Investment systems; Compiling of operating data; Library administration; Computer supported learning; Data-bank and answering systems; Programming aids; Software tools; Handling of sales and distribution; statistics, surveying, building industries, among other uses of software.[131]

International Cooperation and Competition:

The software industry in the FRG has rather a national focus and is subject to

130. IGEP Computer Software Info-Setter. IGEP Projects Edition 4. February 1993. New Delhi-Bad Homburg. p.2.

131. Joachin Broudr'e-Gröger "Internationale Technologie und Wettbewer bis diskussion am Beispiel" in n.122. p.60.

severe competition. About 80 percent of the sales volume obtained by German companies are achieved inland, while foreign companies which are located in the FRG obtain 100 percent of their sales volume in FRG. The total market of the FRG is shared equally (approximately 9 billion DM) between German and foreign companies. Software imports into the FRG exceed by far software exports.

However, both foreign trade flows are still rather small, and if growth does occur this will only be in the field of standard software, mainly because of the language problem.[132]

Therefore, in the FRG transfer of computer technology takes place in the shape of a joint venture. In the FRG, the software scene is characterised by mergers and acquisitions e.g. EI and Cap Gemini. The interest of independent software companies in a secure sales basis and the interest of large companies and corporations in diversification and combining software with know-how seem to coincide so that large companies outside the computer industry such as BMW, Lufthansa or Thyssen are buying shares in software companies to swallow-up competitors for completing their own product range.[133] Because of the major competition the computer technology transfer to India is done by large firms which have their subsidiaries in India. e.g. Thyssen, Siemens, PSI, etc. However, this it is still marginal and not as much as it could be.

One of the reasons is that apart from the fact that a natural adjustment of a rather young market is taking place, the ever tightening competition among the software suppliers is constantly taking place. It is the result of the following factors:

132. Ibid., p.61

133. Ibid., p.27.

1. Hardware Manufacturers are increasingly investing in the development and distribution of software in order to improve their own competitiveness and profit and loss position and are looking for cooperation and partnership.

2. US companies are pushing onto the German market as new suppliers, particularly in the PC field, using an aggressive marketing strategy.

3. Data processing consultants and computer centres are extending their product range by including software solutions.

4. Large-scale users such as steel and automobile companies are marketing their data processing facilities separately and are appearing as new competitors in the market.

5. Scientific institutes are catering to the market as new software suppliers.[134]

A possible reaction upon this development may be the tendency towards a splitting of the software market. Companies on the one side are focussing on standard software, other firms are covering small niches, where prompt solutions are demanded.

Another reason is owing to the structure of German software houses, small companies focus on small segments and a few clients, realizing only small margins and per-capita turnover. Medium-sized and large software houses have problems with the "mass" of the clients due to a lack of personnel, compared with France or Great Britain, in which concentration is more on service activities while development of more software plays a minor part.

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134. Umwelt Forschung und umweltte technologie. Der Bundesminister für forschung und Technologie (Bonn, 1991) p.18.

The demographic and economic shift towards the Pacific region is characteristic of the general situation on the world market. The software market in Germany will also be influenced by this in the near future. In fact, Japan, owing to lack of raw materials, is forced to focus its attention on private services and, for this reason has already declared the development of software as a major national objective for the nineties. A similar potential, compared with Singapore can be expected from the Indian software industry as well as from the People's Republic of China.[135]

Prospects of these future competitors on the German market, however, depend largely upon the growth of the software market in the next decade. Growth rates have stabilised during the eighties as pointed out earlier. There is expectation of further slowing down in the next few years. Reasons for this may be a saturation in the few market segments, such as text processing software, due to the relative high market supply in Germany.[136] Secondly, the preview projects a slower growth in German exports, owing to the general situation in international economics.[137] The transfer of computer technology from Germany to India will, hence, be further marginalised either through direct transfers, joint ventures or subsidiaries.

The VII Plan (1985-1990) period has witnessed considerable growth in the computer industry and the application of computers in many sectors of the economy. The total value of the output was Rs.7000 million (about $233 million) in 1989, nearly five fold increase over the 1985 level of Rs.1500 million (about $50 million).[138] And the output is about to touch Rs.9000 million (about $300 million) in 1990.

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135. Ibid., p.33.

136. Else Fricke, Konzept Zur Gestallung Von Arbeit und Technik Aus Wissenschaft und Praxis (Bonn FES, 1991) p.60.

137. Ibid.

138. Telematics India, (New Delhi) vol.III, no.12 September 1990 p.54.

Reviewing the world's top ten computer manufacturers: (Fig. 7)[139]

Fig. 7

US $m

Rank	Company	Revenue	Revenue
1.	IBM (U.S.)	45.9	44.3
2.	Digital Equipment Corp. (U.S.)	6.2	6.2
3.	Burroughs Corp. (U.S.)	4.9	4.5
4.	Control Data Corp. (U.S.)	5.0	3.7
5.	NCR Corpn. (U.S.)	4.0	3.7
6.	Fujitsu Ltd. (Japan)	6.5	3.5
7.	Sperry Corp. (U.S.)	5.4	3.4
8.	Hewlett-Packard Co. (U.S.)	6.3	3.4
9.	NEC Corp. (Japan)	7.6	2.8
10.	Siemens AG (W. Germany)	16.0	2.8

Primary Source: Datamation.

Secondary Source: Business World, Volume 3, No. 4, October-December 1985.

In India there are about 80 computer manufacturers in the area of computers. The details of the top 5 Indian manufacturers in 1985 are given in Fig 8.[140]

139. Business World. (Bombay) vol.3. no.4. Oct-Dec. 1985.

140. Starred Q.No.9157. Lok Sabha. 7 May 1986.

Fig.8

COMPUTER TURNOVER, GROWTH & MARKET SHARE:
TOP TEN (1988)

	TURNOVER (Rs. Crores)	Growth %	MARKET SHARE %
HCL	60.24	32.3	11.81
WIPRO	54.36	45.7	10.65
ECIL	46.49	48.3	9.12
ICIM	46.29	- 0.2	9.08
STERLING	36.04	120.0	7.06
DCM DP	23.81	3.5	52.28
HINDTRON	23.31	32.7	
ESPL	20.41	30.7	
PSI DATA	18.10	31.1	
ZENITH	15.99	15.0	

Computers can broadly be classified in three categories namely micro, mini and mainframe. However, due to rapid advancement in technology, the demarcation between micro and mini is getting diffused. In recognition of this fact, the area of computers for the purposes of granting industrial licenses has been categories under the two headings namely (i) Mainframe/Super mini-computers and (ii) minicomputer or microprocessor based systems. The mainframe range of computers are all imported. In the mini-computer range about 70 percent and micro computer range about 10 percent are imported.[141]

141. Ibid.

There are about 80 manufacturers in the area of computers. Their products range from mini, micro, supermini and mainframe systems, low end 2D and 3D graphic work stations for CAD and CAM applications. But the majority of production is concentrated in such areas as mini computer/microcomputer based systems.[142]

Certain peripherals like monitors, printless, floppy disk drives are being made in India. The import of peripherals and associated items has dropped significantly from a high level of Rs.2160 million in 1988 (about $72 million) to Rs.830 million (about $27.6 million) in 1989. The size of this market is estimated at around Rs.1300 million (about $43.3 million) as in 1990.[143] With the indigenisation of many components, the computer peripheral sector is all set to become a major growth area.

However, much of the world scenario may not be reflected in the Indian computer market. The share of computers manufactured as a percentage of national GNP in India has been miserable-0.13 percent in 1988 and is expected to touch barely by 1 percent by 2000 A.D.[144]

Nevertheless, it is a fact that since the Government of India announced its new computer policy in 1984, which was ushering a new world of computers into India, the Indian computer industry did undergo radical transformation. The impact of liberal policy, which allowed for cheaper imports and fewer curbs on licensing came in three phases: Phase I where the market for PCS expanded dramatically; Phase II- the minis segment came into the market and Phase III-when demand for mainframe has grown to constitute one-fourth of the total market, with ECIL and ICIM com-

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142. Report of the Workshop on Electronics, Department of Electronics (New Delhi) 1990

peting for market share.[145] The progress of computer industry in India is given in table 4 and [146] table5,[147]

Table 4

COMPUTER MARKET GROWTH

(Rs. in lakhs)

Years	MICRO-COMPUTERS		MINI-COMPUTERS	
	Pieces	- Value	Pieces	- Value
1983-84	1,200	- 2,700	290	- 3,000
1984-85	2,600	- 3,200	500	- 3,300
1985-86	10,350	- 8,190	1,098	- 8,830

Table 5

COMPUTER PURCHASES SEGMENTWISE

Percentage

Segment	Mini-Computers	Micro-Computers
Public Sector	42	34
Private Sector	14	22
Govt. Deptts	23	9
Banks	7	29
Education & R&D	14	6

SOURCE: DATA QUEST MAGAZINE

145. Ibid.

146. Ibid.

147. Ibid.

It was in 1988 that Indian computer companies took a leap forward and outward by tie-ups and collaborations e.g. HCL with Apollo; IDM with Prime Computers; WIPRO with Sun Microsystems; Hindustan with Digital Equipment Corporation (DEC), the world's largest computer giant with sales of $11.5 billion in 1988 as a joint venture named Digital Equipment (India) Limited (DEIL). There were in 1989, 38 tie ups with foreign companies (11 in 1985)[149] of these 13 are agency collaborations (5 in 1985) and 25 are technical tie-ups (6 in 1985).[150]

Increased interaction with foreign vendors is helping minimise the technology lag, provide more attractive hardware features and strive to acquire after sales service standards to match perceived international standards.[151] About 50 percent of Indian users prefer indigenously manufactured systems with foreign tie-ups. Foreign tie-ups do not necessarily mean success. The DCM–Tardy, ICIM-ICL, Tatas-Unisys, ECIL-Norok Data tie ups have not been resounding success.[152]

According to the Indian branch of U.S. based International Data Corporation Survey (IDC), a cumulative demand at 8,000 units by 1991 and for PC-ATS at 26,030 units has been predicted. The current installed base of UNIX systems is under 2,000 each for minis and supermicros. Hence the market can absorb at least 6,4000 mini systems and at least 18,000 supermicro systems. The new application areas would include demand for export and artificial intelligence systems, office au-

149. Ibid.
150. Ibid.
151. Ibid.
152. Ibid.

tomation, CAD, CAM, CAE (Engineering), computer graphics and animation, imaging and CIM Computer Integrated Manufacturing).[153]

It is in the field of software development that India has achieved the greatest success in the computer sector. This is best seen by the fact that though the domestic software market is small at around Rs.1000/-million (about $33.3 million), the export of Indian software has increased from Rs. 750 million (about $25 million) in 1987-88 to Rs.1750 million (about $58.3 million) in 1989-90.[154] And, if the Department of Electronics is to be believed the software export is to increase from Rs.3 billion in 1990-91 to Rs.30 billion by the year 2000 A.D., a ten fold increase.[155]

This performance had been encouraged by the computer policy, 1984, and a software policy in November 1986.[156] The objectives of these policies were to achieve: 1) a quantum jump in software exports and greater share in the international software market; 2) Integrated development of domestic and export markets; 3) Simplification of procedures for rapid growth of the industry which means a) physical exports on magnetic media/paper; b) exports through satellite data links (100 percent exports); and (c) consultancy services rendered at the location of foreign clients using Indian computer expertise.[157]

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153. Ibid.

154. Telematics India, vol.III, no.12, September 1990.p.54

155. IGEP Computer Software Infoletter, ed., 2 (New Delhi) March-April 1992, p.13
Note : Figures have been calculated on the basis of foreign exchange equivalence conversion Rs 30 equals $1.

156. Economic News, vol. III, no.12, Washington D.C., Dec. 1988.

157. Ibid.

A turning policy with this was the import of software, to facilitate export. To make things more convenient, a customs duty rebate of 50 percent was provided and a 100 percent exemption for export oriented units and imports of new or used hardware for purchase and leasing.[158]

The U.S. accounts for nearly 35 percent of India's software exports, followed by the U.K.-Europe sector which commands a 30 percent share.[159]

A notable feature of software market in India is the high degree of concentration with only a few companies dominating both domestic as well as export spheres. At the same time, there are a large number of small units staffed by just one or two persons.[160]

Despite the achievements of the computer industry in India, and the increase in its percentage of contributions to total electronics production from 7.9 percent in 1987 to 10 percent in 1989, the gross turnover of the computer industry remains low compared to the capital employed in the field.[161] In the developed countries, U.S. and FRG, on an average, computers contribute to about 5 percent of GNP formation. In India the figure is about 0.13 percent, evidencing a clear gap between India and the advanced world.[162]

Yet, skilled manpower is one of India's strong points. With as estimated 10,000 trained computer personnel in India, the productivity per software professional has

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158. Ibid.
159. Economic Times, 6 Dec 1990, p.17
160. Ibid.
161. Telematics India, vol.III, no.12, Sept. 1990,p.55.
162. Ibid.

risen during 1988-90, It was estimated at Rs.2.8 lakhs about $.09 million per software person employed in 1987-88 and Rs.3.47 lakhs about $11 million during 1989-90.[163]

Inspite of this, there are serious questions about the validity of employment given by the computer industry, the serious concern about the quantity and quality of computerisation provided by the explosion of training institutes and resulting in about 200,000 trained personnel.[164]

The advocates of computerisation stress increased productivity, increasing job opportunity due to increased economic activity and improvement of quality of labour. But a criticism levelled at the Rajiv Gandhi government was that despite industrial expansion, there had been no corresponding increase in the availability of jobs.[165] The ensuing government followed this attitude and was skeptical on this point, but made no radical inputs into the computer policy.

The International Labour Organisation also surmised that the prospect of the low wage— manpower rich nations in tapping the employment and income potential of the growing software industry are not too bright due to lack of technical expertise, numerous procedural bottlenecks and absence of infrastructural facilities, like data communication networks.[166]

The other side of the issue of employment in high technology industries is that it may not on its own create more employment but as a virtual spin-off create more

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163. Economic Times, 6 December 1990, p.17.

164. Op.cit.

165. Ibid.

166. Ibid.

jobs in the appending service sectors of the same economy.[167] Nevertheless, if not in generating employment, the computer industry may still have a significant role in earning much needed foreign currency. The projections of the Department of Electronics, ambitious as they are, may not be achieved.[168]

The international scene where the East European countries dominated the Indian export scene is now breaking down. The recent events in the Soviet Union, independence of the Baltic states and their recognition by the U.S. also mean that their economy would 'ipso facto' be more responsive to the West, involving a substantial loss to the Indian computer exports.

On the other hand, in the light of the emphasis of controls in Indian governments policy being removed by the 1991 Industrial Policy Resolution, [169] the Indian computer industry stands a better chance, and the transfer of computer technology being more easily facilitated from both U.S.A. and the FRG.

Conclusion

In conclusion, it may be said that in the light of our fore-going analysis, there is a good case for the transfer of computer technology by the US to India. This task may be easier to attain if Indian regulatory policies get sorted out and diplomatic as well as foreign policy both India and the United States.

The important aspect is that in the post cold war scenario, with changing international values, the U.S. still seems reluctant to part with sophisticated computer

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167. Manual Castells, "High Technology, World Development, and Structural Transformation", Alternatives (Berkeley) vol. 11, no.3, 1989 pp86-88.

168. Department of Electronics, Working Report, (New Delhi) 1989

169. Industrial Policy Statement 1991, Government of India.

technology (i.e., the super computer) to India. With the result, India has used its own resources, indigenised it and produced the sophisticated 'Param' super computer. This seems counter-productive when both nations could form a perfectly good partnership.

Germany, with its two in-built problems—mainly language and membership of the European Community—cannot optimally transfer computer technology. Indian foreign policy will have to work towards that. What is more probable is Indian computer software exports to Germany.

This rush for software exports by India is seen as reflecting a perceived competetive advantage the country has in its trained and intelligent manpower. The devaluation of the rupee makes any export business attractive and the global market place offers greater stability than any single country market. Both the U.S.A. and Germany would then form markets for Indian exports.

The major activity in the software Indian market is doing on-site professional services, which would establish the credentials of Indian software professional, worldwide and give them international experience.

Liberalization of the economy, easing of import regulations, ready finance for export oriented activities and encouragement of multinational and NRI investors have all helped spur opportunities for investments in the software.

Indian companies, have, of late, started to resorting to turn key solutions.

It should be remembered that only 4 per cent of the world information technology is accessible to countries such as India and Israel, Ireland, Singapore and the Philippines are competing for this share. A sizable amount can then be earned in software exports through coordinated efforts by both the Government and industry.

Other aspects that need special attention are a re-evaluative study of the role of the multinationals in computer technology transfer, special needs to train mainpower and skills in computers and a very special need for aggressive marketing strategies in software exports. Last but not least is the need to go in for collaborations and joint ventures, keeping in view and insisting on solid R and Dbase. The above requires consistent foreign policy objectives, strategy and a high degree of sophisticated diplomatic negotations.

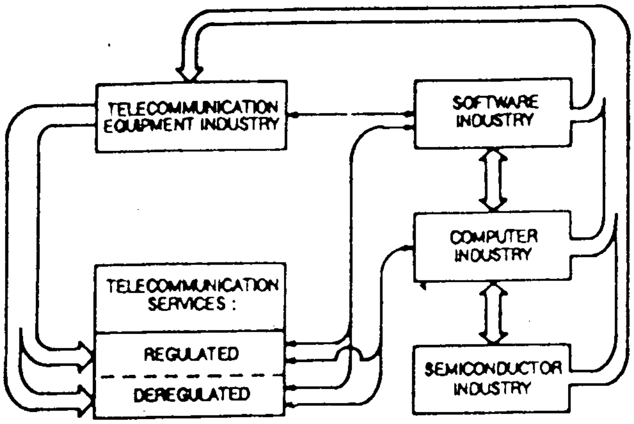
Chapter V

Telecommunications Case Study II

Globalisation of technology is becoming an overwhelming reality in international relations. Telecommunications is the infrastructure of the post-industrial information economy (as in fig 1), fulfilling a role similar to railways, canals and ships which

FIG. 1

INFORMATION TECHNOLOGY INDUSTRY



provided transportation infrastructure for the industrial era. The world economy is becoming increasingly by dependent on the transfer, management, and use of information, largely in electronic form. Fierce competition in markets is fuelling demands for network-based services to increase efficiency, productivity, and strategic competition, which become a pre-condition for doing business and are critical to corporate survival.[1]

1. G. Hariton, P.K. Neogi, "Int elligent Private versus Public Networks: Rivals or Contemporary Allies?" In proceedings of the Tenth International Conference on Computer Communication (New Delhi: Narosa, 1990) p.166

Worldwide spending on telecommunications products system and services is estimated to have accounted for about US $400 billion out of a total information technology market exceeding US $600 billion in 1987 alone.[2] Further, it has been claimed that by the year 2001 A.D., information technology will constitute the largest single sector of the global economy; telecommunications-related spending alone will approach US $1 trillion.[3]

The one major critical issue in conceptualizing telecommunications in an international relations framework is the extent of the pervasive influence of telematics on social, political and economic growth and development of nations.

Developed nations need to implement strategies of telecommunication in an international relations framework. They are able to do this as they are aware of its potential impact. Developing nations are both ignorant of the potential these strategies possess as well as ill-equipped to carry them out.[4]

As science and technology constitute the knowledge capital for socio-economic growth and progress, playing a role as important as resources and infrastructure, their development and exploitation must be considered within the parameters of social and political dimensions.[5] Unfortunately, however, there is a dearth of indigenous material articulating new concepts of scientific and technological developments with the needs of the developing world in mind; theories which are relevant to developed nations are sadly inappropriate in the context of the significantly different en-

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2. Ibid.
3. Ibid.
4. Tengku Mohammed Azzman Shariffadeen, "Telematics, Education and Development-A Developing Country Perspective of Issues and Strategies," ibid, p.70
5. North-South Technology Transfer, OECD Report, Paris, 1981 p.14

vironment of developing nations.

More radical is the rapidly gaining perspective that science and technology are not neutral but value-loaded, whether in the sense of knowledge acquisition or as societal application. They are conditioned by human values or beliefs.[6]

Telematics introduces new science and technology-based parameters into development planning. Developing countries world have to generate a complementary social pull which can further stimulate technical push, forming a mutually supporting balanced system.[7] Most developing nations lack the capability of articulating this social pull and consequently, their development programmes vis-a-vis telematics, tend to be reactive not proactive.

The programme towards a telematics regime must: (1) take into account current needs and capabilities; (2) identify stake holders in each programme; and (3) undertake a multi-dimensional analysis to identify areas of common interest.[8]

In implementation of the above, three operational factors emerge: (1) a champion must be found in a critical organisation; (2) promotion of certain institutions, and (3) means must be found to reduce the financial burden of the project by sharing the cost of development.[9]

Transfer of Telecommunication Technology:

One of the best methods to achieve the afore-cited aims is the transfer of tele-

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6. Thomas S.Kuhn, The Structure of Scientific Revolution, (Chicago: Chicago University, 1970)p.20
7. Muhammad I.Ayish "International Communication in the 1990s: Implications for Third World." International Affairs, (Cambridge), vol. 68, no. 3 July 1992, p. 506.
8. Ibid, n.4, p.72
9. Ibid.

communications technology.

The economy of a nation can no longer be considered in isolation but as a small part of the global economy.

There is now worldwide industrial expansion at an ever-accelerating pace. An essential driving force behind this has been the transfer of technological know-how. Indeed, it is no exaggeration to claim that the international transfer of technology is probably the dominating factor in reshaping the world's distribution of wealth.[10]

Broadly speaking, technology can be defined as the totality of understanding, skills, methods and tools required for the design, manufacture, and use of goods that are useful to mankind. In these terms, the transfer of telecommunications technology is then the transfer of technological know-how between a provider and a receiver. Generally, this transfer is beneficial to both parties.[11]

According to the UN Conference on Trade and Development,[12] 90 percent of technology transfer takes place among industrialized countries; only the remaining 10 percent has so far involved developing nations. Balance of payment figures relating to transfer of technology for several major industrialized countries show that the chemical and electrical/electronic (including telecommunication) industries were the most important sectors even in 1975.[13] Developing countries also aspire for speedier industrialisation. Therefore, business transactions between industrialised countries

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10. R.F. Bizec. Les Transferts de Technologie (Paris: PUF. 1981). p.10

11. V. Malderen. "Worldwide Telecommunication Technology Transfer." International Journal of Technology Management. (Geneva 1987). vol.2. no. 5/6. p.650.

12. Ibid. p.651.

13. Ibid. p.653.

and the First World often include transfer of technology.

Three types of relationships are possible between the technology provider and receiver. First, transfer of technology can take place between two subsidiaries of the same multinational or transnational company. This is generally the optimum situation as both subsidiaries would probably have been working together for many years and the transfer may simply be a repeat of earlier, similar projects. Also, in most cases, financing such a transfer does not present any particular problems.[14]

A second approach is to set up a joint venture between the technology provider and receiver, possibly with the participation of one or more other companies in the host country. The provider then transfers the manufacturing or service technology to the joint venture company which has the task of exploiting and selling that technology.[15]

A third possibility is for the provider to grant a license to a receiver company to use its technology (table 1) In addition to the transfer price for obtaining the

Definition of terms

Patent:	The right of exclusive proprietorship of an invention granted by a government to a person or organization for a term of years.
License:	A right to engage in certain activities for which permission is necessary. An owner of a patent for instance may grant a license for the manufacture of the patented article.
Royalty:	Compensation resulting from the use of a patent, copyright or other property. The royalty is usually a percentage of the sales value of an article or service.
Transfer price:	The price at which a firm sells a good or service from one division of a firm to another, or from one subsidiary to another.

14. Ibid. p.654.

15. Ibid.

technology, the license "will pay royalties to the provider on the basis of product" sales.[16]

Table 2 gives an example of project financing involving the Overseas Private Investment Corporation, Export-Import Bank of the USA, and the World Bank.[17]

Financing Plan

Debt (60%)	
Supplier's government (a)	$250 million
IBRD (b)	$ 50 million
OPIC (c)	$ 40 million
Bank X (d)	$260 million
Total	$600 million
Equity (40%)	
Local government	$ 40 million
Country A	$ 50 million
Country B	$150 million
Total	$240 million
Grand total	$840 million

Notes: (a) EXIM involved for $120 million at 8% over 15 years, (b) Financed at 7.5% over 20 years, (c) Guarantee for private loan, (d) Floating-rate loan.

Telecommunications projects, that is, the creation or expansion of a country's telecommunications infrastructure are usually undertakings of substantial size. Consequently, they require considerable effort, time and money. Moreover, as such infrastructures expand over the years, they require continued systems engineering, maintenance, and additional equipment.

16. Ibid.

17. R.D. Robinson, International Business Management (Hinsdale, Dryden, 1978), p.12

At the same time, the importance of telecommunications has been on the increase over the years, especially with the advent of micro-electronic technology and the introduction of computer-controlled telecommunications systems. With the introduction of digital transmission, and more recently, of digital switching, there has been a dramatic increase in the importance that governments attach to having a modern telecommunications infrastructure, to the extent that participation in this rapid telecommunications evolution, either through purchasing these systems or actual involvement in the technology, is considered as essential to their technological future. Further impetus has been given to this trend by the expectation that the future telecommunications network (narrowband and broadband ISDN) will be the foundation for the so-called 'information age'.[18]

It is not surprising, then, that many telecommunications projects not only include the supply of equipment and the construction and installation of the necessary infrastructure but also some form of transfer of the associated technology. Many governments indeed believe that this route will make it possible to strengthen their electronics and information-oriented industries.

Major categories of telecommunications projects are:

— Public switching systems and networks;

— Public transmission systems, further subdivided into transmission over metallic cable (pair cable, coaxial cable), transmission over fibre-optic cable, terrestrial microwave transmission systems and satellite microwave networks consisting of satellite equipment and earth stations;

18. n.11 p.656

— Cable projects, such as the installation of subscriber cable networks, local junction networ-ks, long-haul routes, and submarine cables;

— Public data networks, including circuit-switched, packet switched and telex networks;

— Mobile radio telephone networks (cellular radio);

— Rural communications networks;

— Projects similar to those above but for public utilities or private organisations such as railroads, government authorities, and banks. These special purpose networks may be based on modern PABX systems rather than public switches;

— Supply of telephone subsets and coin boxes, as well as telex, fascimile and other types of terminals; many projects also involve the construction of buildings, access roads, antenna towers, and so on.[19]

Specifications for telecommunications involving technology transfer are generally issued by public telephone administrations, government authorities, or large private organisations. In addition to a section describing the requirement for direct supply of equipment by the original supplier (technology provider), the specification will include a section that details the type of know-how transfer expected. The manufacturing or service organisation which will be used for the future production or service activity may be an existing company in the host country which will act as a licensee, or a new company (a joint venture company or a subsidiary of the original company). In the case of a joint venture, both the technology provider and the receiv-

19. Ibid.

ing organisation may have significant equity capital in the venture.[20]

Typical activities in the production of the modern telecommunication systems are basically divided into three main categories:

1. Manufacturing of: a) equipment cabinets, racks and subracks b) plastic subset and other terminal housing antennas and waveguide parts; c) printed boards, backplanes and interconnection cables.

2. Assembly : a) components and associated soldering onto printed boards; b) wire-wrapping, and cabling of complete equipment cabinets.

3. Equipment testing at various levels (i.e. components printed boards, subracks, subsystems, entire systems).[21]

The manufacturing process may start at a more fundamental level if certain basic components are produced by the equipment supplier. Examples are the production of custom designed LSI chips, optical instruments, keyboards, display units, connectors and fibre optics, metallic and submarine cables.[22]

In parallel with this hierarchy of manufacturing levels, there exists a range of engineering activities:

1. Research and development, including system design (hardware, software) and the design of custom LSI circuits;

2. Systems engineering, including customer adaptation and application engineering,

20. Ibid. p. 657
21. Ibid.
22. Ibid.

and network planning;

3. Design of software supports tools used for equipment design, engineering and testing.[23]

Levels of technology transfer:

By the very nature of telecommunications projects, they always include at least some minimum level of technology transfer, even if no actual manufacturing is involved. Of all the categories of telecommunication projects listed earlier, public switching networks are the most complex, other projects are in general more straightforward.

One of several of the following levels of technology may be considered for transfer:[24]

1) exchange/network operations and maintenance;
2) exchange installation and testing;
3) repair of defective units;
4) exchange software technology; and
5) switching equipment manufacturing.

The manufacturing of switching equipment is generally handled by a separate company. Installation, testing and exchange software activities could be handled by either or even split between the two.[25]

Exchange of software technology includes a hierarchy of activities of increasing complexity, so the extent to which a technology receiver should get involved

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23. Ibid.

24. Economic and Technical Aspects of the Choice of Telephone Switching System. (Geneva: CCITT. 1981). p. 658

25. Ibid.

the related function needs to be fully evaluated. The following levels of software technology may be distinguished:

1. Exchange database administration;
2. Exchange database and generic programme production;
3. Generic programme design; and
4. Software support tools development.[26]

In most cases, the first activity will be handled by the government. Depending on the size of the network and the rate at which it is expanding, and given that the government wants to handle exchange installation and testing, it might also handle the second activity. However, if the system is being manufactured locally, the second item would normally be handled by the local company.[27]

The third and fourth items required substantial investment in equipment and skilled personnel. It will take several years after the initial technology transfer before any administration or local manufacturing company should seriously consider becoming involved in either of these complex areas.[28]

With respect to switching equipment manufacturing, the labour content is rather low as it effectively consists of assembly and testing of equipment.

It is also necessary to take into account that worldwide, the traditional telecommunication suppliers have been facing similar problems. The increasingly strong competition to achieve an increased share of the market and the consequent larger

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26. Ibid.
27. Ibid.
28. Ibid.

production volumes is causing the present upheaval in the telecommunications industry.

Apart from switching equipment, sophisticated computer terminals connected to the telecommunications network are now used extensively in businesses.[29] The variety is increasing, driven by cheap electronic devices, including even microprocessors, which have given the terminals more logic and memory. A significant trend is the inclusion of increasing intelligence in terminal equipment. The net result is functionality and quality[30]

As far as transmission is concerned, there are two principle types: analog and digital. Graham Bell's invention was, in essence, the discovery of analog transmission, and over the course of the next century, analog voice band took over the communications world.[31]

There are, however, significant advantages in digital transmission in that in-signal degradation is easier to overcome. There is greater flexibility, greater information handling capacity and cost competitive with analog transmission.[32]

Apart from the above, signalling, data services, voice services and some specialized services form the ambit of telecommunications networking.

Underlying technologies and trends:

One of the major technological break-throughs has come about in microelec-

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29. Ian M. Ross. "Telecommunications" in Technological Frontiers and Foreign Relations. National Academy of Science (Washington. D.C.. 1985) p.26
30. Ibid. p.27.
31. R.W. Lucky. Information Journal of Technology. (Geneva. 1987) vol.2. nos. 5/6. p.598.
32. Op.cit. p.29.

tronics, the world of tiny chips of semi-conductor materials, principally silicon, containing a multitude of components through which electrons race to perform complex logical functions at high speeds. These densely packed chips perform complex logical tasks, operate much faster and are cost effective.[33] Fundamental physical limits are not likely to limit microelectronics progress. Near-exponential growth will continue, increasing processing capability of microelectronics and, thus, making possible a variety of new telecommunications and information services.[34]

Photonics or lightwave communications also underline future telecommunications. In this technology, photonics can be generated by lasers, routed by optical switches and transmitted in hair-thin optical fibers. Compared with other transmission media, light wave communication systems have the advantages of broad bandwidth, which provides large information handling capacities, immunity to electrical and electromagnetic interference, low signal loss and small size and light weight.[35]

One of the fastest areas in communications during recent years has been the local area network (LAN) to interconnect users (typically with computer terminals) over a common high speed medium. It seems possible to conceive new LAN architectures which trade the enormous fibre bandwidth in some way for ease and economy of access. These higher speeds should enable new forms of computer-to-computer load sharing and distributed processing.[36]

The unexploited capacity of optical fibers is so great that this should become

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33. Ibid., n.29.
34. Ibid. p.35.
35. Ibid. p.36.
36. R.W. Lucky, "Future prospects in Communication", International Journal of Technology, (Geneva.) vol. 2, nos. 5/6, 1987, p. 600

the medium of choice for all long-distance, point-to-point communications. International capacities should be greatly increased, with concomitant political, economic and sociological impacts.[37] This, along with satellite systems, makes a greater part of a working telecommunications system.

No area of communications is harder to predict than computer communications. While computer hardware will continue to double in capability every two or three years, software will continue to be a bottleneck because it is innovative. Progress in the field may be more dictated by national and international diplomacy, and through standard bodies, than through the traditional research methodologies.[38]

Some of the important events of recent years have been the evolution of LANs, the development of higher-speed voiceband modems using extraordinary sophisticated communications methodologies, the beginnings of ISDN (Integrated Services Digital Networks) with high speed modemless local connection.[39]

In the future, the backbone long haul network will be directly accessible at high data rates through a number of metropolitan area network strategies including atmospherics and fibre optics, radio, dedicated cable and mobile radio approaches.

In sum, lightwave systems are becoming pervasive throughout telecommunications. They link up computer systems, bringing new capabilities right to the customers premises and spreading out between switching centres in the local and nationwide networks to allow greater and more varied services. Because of the rapid

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37. Ibid. p. 601
38. Ibid.
39. World Links. (Geneva,) 1989 no.8. p.66.

progress being made and the great potential remaining, lightwave technology is expected to dominate future transmission systems.[40]

Another major telecommunications technology, software, refers to the sets of instructions that tell the logic elements what action to take and when. Software determines what processors can and cannot do. The telecommunications network has come to depend increasingly on software e.g., software used in the ESS switches in the bell and A&T networks handles more than 500 percent of telephone traffic.[41]

One factor arising out of this software support is reliability. Other factors relate to fault location, diagnostics and maintenance. The benefits to be released from advances in microelectronics depend heavily on software. If additions continue to the telecommunications network, more complex system will be needed for reliability and cost effectiveness.[42]

It is to be noted that telecommunications has imparted change in business, trade and industry, education, healthcare. Banking and retail system have changed due to telecommunications; so has electronic mail changed the system.[43]

Similarly, national security in the international relations framework, has benefited from emerging technologies mainly because new telecommunication technologies provide new capabilities and applications in microelectronics, photonics and mili-

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40. Ibid. n. 79.
41. Ibid.
42. Shanti Jagannathan , EC and India in the 1990s: Towards Corporate Syneigism (New Delhi: India Publishing House, 1993) p. 233
43. Ibid.

tary systems along-with analog and digital computers, microwave and signal processing which had earlier applied themselves in military systems.[44] Thus the important point is that in high-technology, military and civil applications become symbiotic.

There is a common purpose pertinent to information technologies; to provide the users with the information they want, when they want it, and in the desired form. Potential applications are as numerous as the sources of information available in a society; which applications will emerge will depend on factors other than technology.[45] It will depend on policy making of nations and relations between nations.

<u>Motives of the U.S. to transfer telecommunications technology:</u> Most of these have national and international impact: 1) It is perceived as the U.S. interest to help friendly developing countries.[46] Telecommunication technology can help speed up advancement of developing countries. Yet the U.S. model or transfer may not be totally appropriate for India. The opportunity does exist to develop basic and specialized services, together and in combinations that are most appropriate to the needs and desires of each country.

2. The U.S. perception is that it continues to place high importance on maintaining a free and open society—technologically and commercially competitive.[47]

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44. The Times of India, New Delhi, 5 April, 1991

45. Todd A. Watkins. "Beyond Guns and Butter: Managing Dual-use Technologies" Technovation, vol. 10, no. 6 September, 1990, p. 390.

46. International Technology Transfer : Who Is Minding the Store? Hearing before the subcommittee on International Scientific Cooperation, U.S. House of Representatives, 101st Congress, July 19, 1989, no. 70 Washington D.C., 1990 p. 3-7

47. 1991 Science & Technology Posture Hearing with the Director of the office of Science and Technology Policy before the Committee on Science, Space and Technology, U.S. House of Representative 102nd congress. Feb. 20, (Washington, D.C.,1991) no. 1 p. 13.

Modern telecommunications make political boundaries essentially transparent and U.S. telecommunications transfers almost imperative to improve the quality of life.

3) Telecommunications technology, according to the U.S., should continue to contribute positively to the international balance of trade.[48]

A leadership role in telecommunications technology is a prerequisite to a strong international market position. Because of established relations between governments and their telecommunications industries, markets for telecommunications network equipment are among the most restricted in the world.[49]

The pervasiveness of telecommunications technology does affect the trading positions of the U.S. vis-a-vis countries with which it shares its technology.[50] The U.S. wants to maintain its technological leadership; hence, transfer of technology is only to this end and has sometimes introduced ''time lag'' into the transfer of technology process, but this approach risks the loss of market opportunities if others are willing to trade long term opportunities for short term projects.

Thus, the tendency to require surrender of technology as a condition of market entry is developing into an issue demanding U.S. government attention.

4. According to U.S. perceptions, worldwide technical standards must be developed expeditiously and in a politically unbiased way.

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48. Trade and Technology Implications of the GATT Negotiations. Hearing before the Subcommittee on Technology and Computation 102nd congress July 30, 1991 no 46. Washington, D.C. 1991, p.11.

49. Ibid, p.2.

50 Ibid, p.13-22

These standards are critical to the evolution of the information age and have to be firm enough to ensure compatibility between old and new products and wide enough to ensure rapid introduction of new technology.[51]

These questions are highly political. A major challenge to be met rapidly would be to separate the technical from the political. The pace of technological change is such that rapid resolution is essential if society in general is to receive the maximum benefit from the technologies being developed. Also, the competitiveness of the U.S. behoves it to have an effective voice in discussions on international standards.

5. The telecommunications industry will continue to support the national security and defence needs of the U.S.[52]

The U.S. underlying critical technology is vital not only for military and emergency preparedness communications, but also for military command and control functions, referred to as C^3I,[53] which is the core of military effectiveness (as seen in the recent Gulf war). It affects U.S. security and defence needs. This ubiquity of telecommunications technology underscores the U.S. need for technological international leadership. It also poses the difficulty of implementing an appropriate export policy for both technology and products.

Telecommunications technology is capital intensive, both for R&D and for manufacture. A clear and stable trade policy with appropriate export controls, according to U.S. policy makers, with industry-government interaction will make better

51. Ibid. Critical Technology:OSTP Report. Hearing Before the Subcommittee on Technology and Competitiveness 102nd congress. April 25. no.20. Washington D.C..1991 p.9.

52. Ibid. p.14

53. Ibid. p.15

ground for international competitiveness.[54]

Since telecommunications services themselves are directly critical to national security, they are key elements in programmes for verifying demilitarization and thereby provide a mechanism for maintaining peace as well as military effectiveness.

In the U.S. perception, improving the flow of technology from research to practical use of manufactured products is essential to winning the 'Technology War'. Accomplishing that means dealing with a fundamental management problem, the complex task of finding a method for shepherding an idea from economics, government policies, law and most of the information technology, i.e., telecommunications and computer technology, does transfer from U.S. national military technology to civilian industrial technology under the dual use technologies and therefore, the involvement of the U.S. government is high. This further involves the U.S. legislative acts in controlling and guarding technology. The 1965 Brooks Bill and its successor, the 1982 Paperwork Reduction Act, introduced an administrative swamp that delayed the government itself from using state of the art technology and imposed on each federal agency the requirement to institute complex bureaucratic systems to monitor and manage their data processing systems.[55]

Other government acts of some consequence came in 1981, with the U.S. versus IBM anti-trust suit and also the consent decree imposed on AT&T in their case with the government. Both of these cases throttled the pace of innovation; for example, IBM's generosity toward universities during the 1970s was severely cur-

54. U.S. Manufacturing Capabilities, Hearing Before The Subcommittee on Technology and Competitiveness, 102nd congress, 27 Feb 1992, (Washington D.C., 1992) no.102, p.39

55. David Brandin, Michael Harrison, The Technology War, (New York: John Wiley and Sons, 1987) p.182

tailed and AT&T was compelled to stay out of the computer business for some time.[56]

The Privacy Act, Presidential Directives, and other bills, from 1974 to date, have been useful in protecting citizens rights and imposing more users. But, along with the consequences of the Brooks Bill, the cost in reduced technology transfer has been enormous. Transferring telecommunications technology requires that marketing people must be in the country of sale. Therefore, geographic dispersion does not really help. Transferring technology is an awkward and tedious process.[57]

6. It is important for the United States from the preceding points to retain a position of leadership in the sciences and technologies underlying telecommunications.[58]

To retain leadership, those telecommunication technologies that are important either to national security or to international competitiveness and sometimes both, entail not only adequate R&D but also adequate mechanisms,such as manufacturing technologies, for converting the resulting science and technologies, base into competitive projects and services. Unless governmental policies support this objective, there will be no advancement.[59]

However, a policy of primacy does not preclude a policy of cooperation. Thus, there should be opportunities not only within the Western alliance which is taken for granted, but also with developing countries like India to share in the development and use of new telecommunication technologies. Such cooperation would

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56. Ibid.
57. Ibid. p. 56.
58. American Technology Pr Act. H.R. 1989. Hearing before the Subcommittee on Technology and Competitiveness 102 congress. 26 and 27. February 1991.
59. Ibid., n. 54

also be a tool for improving India-North and North-South relations.[60]

Thus, it would seem that leadership in telecommunications is a useful adjunct of effective foreign relations, since the ultimate objective of both is to improve the quality of human existence and in the larger framework, international relations.

7. It is the U.S. perception that the intellectual property rights of U.S. nationals be adequately and effectively protected throughout the world.[61]

This, of course, means that robust intellectual property protection fosters transfer of technology by facilitating licensing, disclosing innovations and creating incentives to publish research results. Access of local firms to new technology is thereby increased which, in turn, fosters economic growth.[62]

On the positive side is seen a causal linkage by the U.S. between the presence of efficient property rights, including intellectual property rights and economic modernization. Patents are supposed to encourage private innovation. Innovation creates technological change, which is the main engine of economic development.[63]

Technology for a long time has been regarded as a ''free good''.[64] Therefore, the other side of the argument from the U.S. is the ''technology is a part of the

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60. Impact. (Washington D.C.) no. 70. 1990 p.25

61. Helena Stalson. Intellectual Property Rights and U.S. Competitiveness. Impact (Washington D.C.) no.57. 1987/1 p. 11

62. Ibid.

63. Copyright Protection for International Property to Enhance Technology Transfer. Hearing before the subcommittee on science. Research and technology 101st congress Washington D.C. 1990. 26 April 1990 no. 117

64. Robert U. Ayres. ''Technological Protection and Piracy''. Impact (Washington D.C.). no.57. 1987/1. p.36.

universal heritage of mankind'' and the patent system should be dismantled over the world, releasing all proprietary knowledge and ''low cost'' transfer to developing nation.[65]

Yet, by a well known statistical process, the regression analysis, it is found that the level of economic development correlates closely with the level of patent protection; nations with stronger patent systems experienced more rapid economic development. This happened for three reasons: First, well developed patent rights foster economic growth, so that nations that upgrade their intellectual property rights system can expect improvements in the rate of innovation and investment in innovative activities. Second, inadequate property rights impede economic development. Weak patent regimes can be expected to correlate with economic backwardness. Third, as economic development occurs, it makes patents and other intellectual prospects for sales and profits from their exploitation.[66]

India, Brazil and Argentina are among the weak protection regimes, despite the size and complexity of their economies. There is insidiousness in this regard as developing nations themselves for the most part cannot protect their industry from infringement and would also like to pool in and transfer technology at low cost since most technologies are used over and over again[67] even through the ''right'' in intellectual property rights involve trade-marks, patents, copyrights and other protective forms (royalties, licensing fees) governing industrial and artistic creations.[68]

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65. Ibid.
66. Ibid. n. 63.
67. Ibid.
68. Ibid.

It is becoming relatively easier for recurring infringement and easier reproduction to take place.

Software piracy has assumed immense proportions; of the roughly $ 50 billion market for software in the U.S. alone, approximately 5 billion is illegal software. According to a U.S. Department of Labor study in 1987, rampant software piracy has been noted in the Philippines, Thailand, Malaysia, Indonesia, Mexico, Argentina, South Africa, India, apart from the "Four Tigers", Hong Kong, Singapore, Taiwan and South Korea.[69]

The world software industry loses approximately U.S. $ 5.7. billion in sales due to piracy. Of this, the U.S. market alone lost $ 4.1 billion in gross revenues in 1986. The International Trade Commission study conducted in 1987 covered global hardware and software industry. It surveyed 47 computer manufacturing companies and 52 software developing firms found that up to 95 percent of the software pirated was of U.S. origin. The major offending countries included the Four Tigers, China, India, Indonesia, Japan, Mexico and Thailand. Of these, only Hong Kong took corrective action and has not come onto the U.S. hit list.[70]

India did not figure prominently in the Department of Labor study, not because the levels of piracy were lower, but the levels of computerisation itself were considered too small to make it an issue of international concern.[71] Yet, there is a lot of insecurity of India's potential in the software market.

To stem these very infringements, an effort was made in the 1970s at the General

69. Business India (Bombay) 22 August, 4 September 1988, p. 144

70. Ibid.

71. Ibid.

Agreement on Tariffs and Trade (GATT) to draw up an international code. It failed to get enough support. A second effort in the late 1970s led by U.S. business sectors resulted in patents and copyrights being covered by the international code.[72] There was a strong feeling that the existing international institutions concerned with intellectual property matters, and particularly the World Intellectual Property Organisation ((WIPO) should be able to handle the problems.[73]

In the September 1986, the GATT meeting in Punta del Este, Uruguay, agreed, among other things, to include intellectual property on the GATT agenda for the 1988 Uruguay Round that would shape international trade relations for the rest of the century.[74]

Less satisfactory to the U.S. private sponsors were signs in mid-1987 of a weakening of what had seemed to be a growing support in other developed countries.

Not enough progress has been made since then in the U.S. view, especially the February 1988 report, when U.S. International Trade Commission arrived at larger than expected losses. The U.S. industry incurred losses from $ 10,000 to $ 5,000 million for individual firms; the aggregate came to $ 23,800 million.[75]

Of the 167 firms that provided data on estimated losses, the largest amount was in the scientific and photographic industry. Next were 25 firms in the computer and software industry ($ 4,100 million), 11 firms in electronics ($ 2,300 million) followed by losses in manufacturing entertainment industry, video recording

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72. Ibid. n.61
73. Ibid.
74. Ibid. p. 8.
75. Ibid.

and pharmaceutical firms.[76]

Somehow the US feels itself to be practically a loner in the cause of intellectual property rights. FRG has a very ambivalent approach to intellectual property rights.

The Japanese use and improve upon U.S. patented technologies, says Paul Cook, founder and CEO of Raychem, which in a nutshell, explains Japan's innovativeness and competitiveness. ''What's frightening to me is the thoroughness with which the Japanese scan the world for developing technologies, learn them, know the patent literature, know the technical literature, and turn over every stone.[77]

The Europeans are less eager to protect intellectual property and the mantle of leadership in this regard seems to have been taken up by the U.S. which tries to work this out multilaterally and bilaterally as is evidenced.

Certain countries appear to protect intellectual property but exclude certain industries from coverage by the intellectual property regime. India denies product patent protection to innovations in the food, chemicals and dye industries.[78]

This has resulted in the 'Special 301' on intellectual property being clamped on India by Carla A. Hills, the United States Trade Representative.[79]

The objective of Special 301 is to enhance the U.S. administration's ability to

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76. Ibid.

77. W. Taylor, ''The Business of Innovation: An Interview with Paul Cook'' Harvard Business Review, (Boston) Mass 1968, p.10

78. ''Protection of Patents in India'', paper circulated by the Government of India, 1989.

79. Omnibus Trade and Competitiveness Act, Economic Times, USICA, (New Delhi), July 1988.

negotiate improvements in foreign intellectual property regimes through bilateral and/ or multilateral initiatives.[80]

China, India, Thailand have been on the U.S. Administration's Special 301 "Priority Watch List" since the first annual review in 1989. In each case, the practices of these countries according to the U.S. have been found to be egregious, resulting in an adverse impact on U.S. industry.[81] India has been identified as a priority foreign country because it provides an inadequate level of patent protection, including too short a term of protection for certain classes of incentives, particularly pharmaceuticals. Many U.S. patented products are widely pirated. Copyrighted material, including books, videos, sound recording, computer software is also pirated Finally, market access for motion pictures is severely restrained through quotas, free and other barriers.[82]

India, on its part, feels that provisions of the Special 301 negotiated and hankered over since 1988 are unfair, unequal and discriminatory. Trade and IPR definitely ought to be regulated but not totally controlled.[83]

Even the Cray X supercomputer came under a lot of flak within the ambit of the Special301 provisions of the U.S. and was delayed because of it. The former Indian Ambassador to the U.S., Abid Hussain, has stressed the need to rethink India's policy on the IPR to improve potential economic relations between the U.S. and India.[84]

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80. Economic News. USIS. (New Delhi). June 1991. p. 6.
81. Ibid.
82. Ibid.
83. Times of India. New Delhi 4 September 1991
84. Times of India, 20 August 1991.

It is upto the U.S. as the foremost world leader of trade to rationally maintain IPR in its favour but not arbitrarily discriminate against India.

The new information technologies including telecommunications, computer and electronics affect society. They change the way people work, interact, learn, create, process information, and their needs and expectations.[85]

Technology, development and information learning are inter-related. IPR, according to U.S. perception is to protect this relationship. Yet, as the Australian Prime Minister Bob Hawke told the GATT delegation in Geneva in October 1987, "the resolution of the difficulties facing the world trading system is not, and must not be allowed to be a master exclusively for the major trading nations".[86]

In which case there must be adequate margin given to India and discrimination exercised to see to a proper regime regarding information technologies being established.

On the face of it, protection seems to provide opportunities for new ventures to establish themselves before facing the full force of foreign competition. Many new firms in semiconductor and microelectronics technology have been successful in the U.S. As to why India should need protection in its own markets is impessible for Americans to understand.[87] Yet, to lower capital costs and have fewer regulatory restrictions is not enough. Innovation needs to be protected wherever it originates. Intense competition in

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85. "Disseminating information: Evolution of a Concept: U.S. Office of Technology Assessment". Economic Impact (Washington D.C.) no. 64, 3, 1988, p. 28.

86. Talal Abu-Ghazaleh, "The GATT and Intellectual Property" Economic Impact, no. 64, 1988/3, p. 28.

87. Robert U. Ayres, Technological Protection and Piracy, Economic Impact no. 57, 1987/1, p. 40.

the field of semiconductors, electronics, computer software made it hard enough for nascent firms but governmental protection is not the only answer, effective international relations is. Intellectual property right protection almost becomes an 'imperialist' mode of regulating trade, which should not be the case.

FRG's Telecommunication Policy and Input:

Virtually all governments today realize that they must deregulate the telecommunications sector to achieve a competitive environment for corporations. However, there is no reason for governments to rely on the same regulatory model. Instead, each country must consider its political traditions and cultural values before choosing its own path to a liberalized telecommunications regime.

For the FRG, decontrol must include the availability of high quality basic service to all regions of the country. Geographically, Germany is too small to accommodate more than one network.[88] In addition, competitive network operators would quite naturally concentrate on high-value urban centers.

In order to ensure an infrastructure of consistent quality, FRG relies on a national monopoly where necessary, allowing competitive forces to handle the remaining sectors of telecom.[89] So, while the basic network will remain a monopoly, equipment and services will be offered through a fully competitive market. This, one can say, is almost akin to that of India.

The approach to deregulation reflects West Germany's history. Unlike France, which is a centralized state, Germany has powerful federal states which demand equal access to national infrastructure such as transport and telecom network.[90]

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88. Christian Schwarz. World Link no.6 (Geneva.) p. 71.

89. Ibid.

90. Ibid.

Germany also differs from the U.S. which is a huge country with a political culture that accepts economic development as a dynamic process permitting inequalities among regions.

In contrast, Germany's constitution requires the federal government to offer equal opportunities for economic enterprise throughout the republic. This is according to the then German Federal Minister of Posts and Telecommunications Dr. Christian Schwarz Schilling.[91] He also felt that the differences between German and U.S. telecom systems were not too many and that the U.S. telecom system was far more regulated than generally thought.

It was, in fact, to restructure the telecom system that the Bundespost in FRG had been taken up as a classic example to result in a superb infrastructure in combination with more competitive prices, equipment and value added services. Privatization of the Bundespost is not allowed under the FRG constitution but within 10-15 years, FRG hopes to achieve comparable results to those countries taking the privatization route.[92]

International cooperation, communication and relations will be facilitated if FRG were to become a major telecom centre which it intends to.

Outside of Germany, the rest of Europe has also been deregulating the telecom sector in anticipation of 1992 and as a competitive base vis-a-vis Japan and the U.S.

The FRG telecom policy and programme has to be viewed within that of the European Community's programme, because it is a part of the EC telecom regime.

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91. Ibid.

92. Ibid., p. 72.

Developments, Aims and Policies of Telecom in Europe:

The data processing in the telecom field, as a whole, already has an annual turnover worldwide (for equipment and services combined) of well over DM 1000 billion. In 1986, the world market for telecom equipment was worth almost DM 200 billion, with the Community market accounting for some DM 38.5 billion.[93]

From generating 2 percent of Community's GDP in 1984, the telecom and related sectors could well account for as much as 7 percent of GDP by the end of this century. By the year 2000, more than DM 1000 will have been invested in the telecom sector.[94]

Growth and investment of this kind have a tremendous impact on data processing, software manufacture, microelectronics, provision of new services and the media. Along with this, it is estimated that employment will increase from the current 1.3 million jobs to about 60 million dependent on information technologies and telecom services by the end of this century.[95]

The driving force behind this technological revolution is digitization, which is the 'computerization' of telecom. It is through digitization that computer technology has become the basic technology of telecom. Combined with the rise in R&D costs, especially of software development, this is giving rise to a drastic restructuring of the telecom industry in Europe.

Almost all the member states of the EC have initiated a reform of the regula-

93. Narjes, "Telecommunications: Political Challenge for the European Community," International Journal of Technology Management, (Geneva), vol. 2, no. 5/6, 1987, p. 636.

94. Ibid.

95. Ibid.

tory framework.[96] In U.K., Netherlands, France, Italy, Belgium, Spain, Portugal and Luxembourg reforms in regulatory framework have been initiated.[97]

In the FRG, the Government Commission on Telecommunications, under the chairmanship of Professor Witte has had significant impact on policy and legislation in the telecom sector.

The restructuring of the telecom sector coincides with the Community's target of completing the internal Community market by 1992. The main factor needs in this consensus within the Community. It has been the aim of the Commission's Green Paper to create that consensus and to dispel the allusions to 'Fortress Europe' in the information industry.[98]

The general aims of the positions set out in the Green Paper are: To offer a wide range to telecom services to the European users, on the best possible terms; to ensure consistency of development in the member states; and to create a competitive environment, taking full account of the technological development already in progress.[99]

No individual member has more than 6 percent share of the world telecom market, whereas the USA accounts for 35 percent and Japan 11 per cent.[100] The EC market as a whole represents over 20 per cent [101] of the world market, which is why

96. Commission of the European Communities. "Recent Economic Trends". European Economy supplement A. no. 5/6. May/June 1992.

97. Ibid.

98. David R. Warlock. "The Information Industry's Two 1992 Tasks" in European Affairs. (Amsterdam) vol. 4. no. 1. 1990. p. 93

99. Ibid. p. 94.

the Community needs Community-wide competitive structures.

The networking through Europe requires the introduction of ISDN and integrated broadband communication. Therefore, the Green Paper further underlines the significance of the Community's RACE programme which is not merely to develop a broadband network. Its main thrust lies in the creation of a climate of cooperation among the telecom administrations involved in designing and building the system, and also between them and the system.[102] This is why the RACE programme is being pushed to be adopted without delay.

Closely aligned to this was the ESPRIT programme (outlined also in chapter III), which laid the foundations for intensive collaboration between European manufacturers and researchers in the information technology field. Hence telecom is an important regime in civil and military fields of application.

ISDN and Its Implications:

A vital aspect of Integrated Services Digital Network (ISDN) is the definition of its characteristics through internationally agreed standards. Although standards for ISDN are still evolving, there is common agreement on the general technical principles and network architecture.[103]

After premising that ISDN will be based on digitized system, it was agreed internationally in 1980 that ISDN would have the following characteristics:[104]

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102. Ibid.

103. Fink and Marco, ISDN Standards for Public and Private Networks, International Journal of Technology Management, Geneva Acroport vol. 2., no. 5/6, 1987, p. 662.

104. K.H., Rosenbrock, "Development of ISDN in Europe", International Journal of Technology Management, (Geneva, 1990) vol.2, no.5/6, p.607.

1. It is to be characterized by a minimum number of interfaces which, however, are internationally standardized.
2. It is to allow the connection of a multitude of terminals using a standardized interface.
3. It offers additional services, apart from telephony.
4. It is a universal telecom network providing 64 Kbit/s connections between any terminal points.
5. It is to be media independent, i.e. in principle existing so that any future transmission media can be used.
6. The extension to include broadband services is to be planned, and
7. The transition to ISDN will take some time to be completed.

Introduction of ISDN by the Deutsche Bundespost:

In order to test the functioning of all new ISDN components, the Deutsche Bundespost implemented in 1986-87 an ISDN pilot project in the local networks of Mannheim and Stuttgart with about 400 ISDN accesses each.[105] The acceptance test of two ISDN local exchanges were performed in 1987 and the exchanges are running well. Commercial operations have begun by end of 1988. By 1993, the Deutsche Bundespost will be in a position to provide ISDN features nationwide, with value added services e.g. telephony, data transmission, telex, telefax with effective costs.[106] ISDN will moreover, form the basis for a Communitywide telematics market. It will be a political challenge, too, for the EC to have regional networking on this wide,. sophisticated and complex scale. This should be entirely feasible by 1995.

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105. Ibid. p.617
106. Ibid. p.619

As the single market movement gathers speed in European information industry sector, a major drawback, an intractable problem looms large: language.[107] English being the accepted format, it becomes obstructive to the EC nations in the information industry and therefore limits the potential users. It is here that a major challenge lies, and it has to be overcome.

Further, the information market after 1992 can look for genuine telecom liberalisation, the creation of simple pan-European systems in the telecom field, and an integrated approach to broad band satellite information-distribution,[108]

FRG's Transfer of Telecom Technology to India:

Free flow of information caused turmoil in countries such as East Germany and the Soviet Union and forced them to look outwards, thereby changing the intrinsic political structures and revolutionising societies. The FRG too realised the potential of telecom transfer.

"Today's information society is a contradiction to a centralized system of governance. Technological changes in telecom are causing economic and political upheavals worldwide", remarked Dr. Konrad Seitz, the former FRG Ambassador to India in his address to the Seminar on National Telecom Perspectives in FRG.[109] He further mentioned that the FRG saw India as the best placed among developing countries to allow participation of foreign capital in information technology due to several positive indicators, such as a large middle class market, dynamic spirit of entrepreneurship, high degree of software competence etc.[110]

107. Ibid. n.98.

108. Ibid.

109. Telematics India, vol.4, no.1, October 1990, p.6.

110. Ibid.

Moreover, as already outlined, the evolution of the ISDN and related services in the FRG, 30 million subscribers out of a total 60 million population are demanding new services,[111] according to Dr. K.H. Rosenbrack of the BMPT.

With the unification of Germany, its telecom industry has an even bigger market. For India to be able to get the FRG to transfer telecom technology is a major enterprise. This level is quite low as seen by statistics in the ensuing section and in the firm analysis of FRG's major firm Siemens.

In terms of qualitative transfers of telecom technology, the FRG has—indubitably been the foremost in railway signalling, digital transmission equipment, and push button phones mainly through Siemens AG.[112]

Indian imports from West Germany in electronic technological products have been as follows:[113]

(In million DM)

1985	1986	1987	1988	1989	1990	%age
437.2	477.7.	382.2	346.1	365.0	307.4	-15.8

This shows a negative trend in imports towards 1990. Yet, the maximum number of foreign collaborations in telecom is with FRG (27) followed by the USA (20) and Japan (20) out of the total 143 collaborations in telecom with major MNCs.[114]

111. Ibid.

112. Agriculture and Industry Survey 1989. Indian Telecom Foreign Technology vs Indigeneous Efforts. p.133.

113. Statistiches Bundesamt 27 March 1991. No. 1327 TB01.

114. Arun Bhattacharjee." Telecom: Forge Alliances or Bust". Telematics India. (New Delhi) vol. 3 no. 20. July 1990. p. 50

While indigenous technology is developing surely but slowly, the greatest demand in collaboration has been in switching, transmission, user terminals and modems.[115]

In fact, under the aegis of the transfer of technology from FRG, there has been an agreement signed between the Government of India (STQC Directorate) and the Government of FRG (GTZ), a technical cooperation project on quality improvement of electronic products which is currently being implemented by STQC Directorate.[116] The FRG government will provide an amount of DM 15 million. [117] The FRG Government has agreed to cooperate in 11 topical high technology areas during this phase of the project, some of which are opto-electronics, industrial and consumer electronics, interconnection technology.[118] The FRG Government has also aimed at helping in training activities and institution building.

The transfer of high technology in telecom from the FRG to India is, therefore, done mainly on a government-to-government basis. It is qualitatively high but low volume wise. Government of India policies need not only to be restructured but induce political confidence in policy and also wisely implemented. The disadvantages in India are: (a) red-tapism; (b) insufficient trade liberalization; (c) non-convertible currency; (d) increasing exports.[119] The advantages are that India is : (a) labour intensive; (b) able to easily absorb high technology; (c) has a low wage structure.[120] Policies are the main detriment to this transfer, when problems can very easily be

115. Ibid.

116. Department of Electronics Working Group Report on Electronics. 1989-90. Government of India. p. 56.

117. Ibid.

118. Ibid.

119. Interview with Dr. Dietrich Kebschull. Director. Indo-German Export Promotion Project. New Delhi. 6 May 1991.

120. Ibid.

resolved with rational factor combination between FRG and India.

Backgrounder to Indian Telecom:

Telecommunications is a national resource. It is a complex segment which links international, national, developmental, operational and service sectors and covers aspects which affect industry, agriculture, transport, etc. Transportation and communication services are complimentary, but communication is less energy intensive and ideal for development of India.[121]

Telecom has become one of the most critical segments of our economy. Rapid growth of industries and services need a greater degree of support of telecom technology. Telecom services can help in the integration of rural economy with the other segments rapidly.[122]

Worldwide (for about 5.0 billion people), there are about 500 million telephones (10 telephones per 100 people), of which 80 percent are in the advanced countries.[123] 100-odd developing countries have less than 40 million telephones in operations. Telecom equipment market worldwide is estimated to be over 100 billion US $ per year and growing at a rate of about 10 percent annually. Telecom market is dominated by a small number of multinational companies. Forty percent of the telecom market consists of switching equipment. Capability building in switching equipment technology is vital from the long term and strategic point of view for India's growth and export potential.[124]

121. Electronics Information and Planning, (Electronics Commission, New Delhi) Feb. 1991, vol. 18, no. 5, p. 223.

122. Ibid.

123. UN Statistical Yearbook, (New York.) 1988.

124. Electronics Information, p. 223, 143, n. 140.

Information technology industry is one of the rapidly growing segment in International Trade. GATT has reported that computers, integrated circuits and telecom equipment are the three topmost categories which have been identified as dynamic products in world merchandise trade during 1979-87 period, as shown in table 3.[125] The three categories account for 159 billion U.S. $ for ten percent of the manufactured exports in value terms.

TABLE 3.

Three Top Most Growth Categories in World Merchandise Trade

Category	Value of trade	Average annual growth rate (%)		
	(Billion US $: 1987)	1973-87	1987	1979-87
Computers and Peripherals	85	19	27	18
Integrated Circuits and Transistors	38	18	30	15
Telecom Equipment	36	11	18	13

Apart from this, globalization trends of industries, European unification[126] in 1992, liberalization of Eastern European economics, emergence of networking among European partners[127] make telecommunication a very important sector of growth. These are the inputs on which hang the international relations factors linking up with telecom.

Telecommunication, a highly dynamic sector, is undergoing rapid and profound structural change of great magnitude. This sector is showing an economic growth rate which few others can match. The changes taking place in the telecom area can

125. GATT. International Trade. (Geneva. 1989) 1988-89. vol.1 & 2.

126. C. Stevens. 1992: The European Technology Challenge. (Geneva) Research Technology Management. January 90. pp.17-23.

127. R.V. Tulder and G. Junne. European Multinationals in Core Technologies. (Chichester Willey: 1988) p.80

be summarized as follows:[128]

(a) A large number of products and services are being introduced, constantly expanding the market;

(b) Several of these products require new telecom infrastructure e.g. digital transmission and switching systems and integrated services digital networks (ISDN);

(c) As a result of the increasing convergence of telecom and computer technologies (as already evidenced), there is a strong tendency towards integration in terms of acquisitions, joint ventures, collaborations between telecom, computer, semiconductor and software firms;

(d) Telecom industry is a part of the information industry as shown in figure1[129] and in most countries this is identified as a strategic industry not only because of the size of its output, but also because of its potential effects on other sectors of the economy.

Telecom is part of the new emerging information communications technology paradigm. Some of the characteristics of this technology cluster are:[130]

(a) The time between design-prototype trial and commercial production is coming down;

(b) Technical information is highly proprietary and it is not easily available (refer IPR);

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128. Economic Commission for Europe. The Telecommunications Industry. (Geneva, 1987) ECE, United Nations E.87.II. E.35.

129. Electronics Information & Planning. (Electronics Commission, New Delhi) Feb 1991, vol. 18, no.5, p.224.

130. Ibid. p.223.

(c) The technologies are multidisciplinary and skills for developing them are not easily available in developing countries. This is, of course, not the case in India;

(d) Commercial and technical information needed for these new technologies cannot be clearly demarcated.

These characteristics make it difficult for developing countries to master these new technologies quickly. Finally, telecom equipment technology has a high R&D intensity;

Table 4 gives the R & D expenditure of major firms operating in the area of telecom technology.[131]

R&D Expenditure of Selected Firms Working on Telecom Technology

Firm	Country	R&D Expenditure: 1988 (Million US $)	R&D Expenditure as % of Sales
ATT	USA	2572	7.3
Siemens	W.Germany	3690	10.9
ITT	USA	525	6.1
Northern Telecom	Canada	710	13.1
Ericsson	Sweden	550	11.2
NEC	Japan	2008	8.8
GTE	USA	251	1.6
IBM	USA	5900	14.7
CIT/Alcatel	France	1005	7.7
Fujitsu	Japan	1498	8.9
Plessey	UK	196	6.6
GEC	UK	1196	10.3
MITEL	Canada	55	12.7
HITACHI	Japan	2204	4.7
PHILIPS	Netherlands	2338	8.2
ITI	India	22	5.7
BEL	India	17	5.7

131. R & D Score Board. Business Week. (Bombay) Aug 14. 1989.

TABLE 5

R&D Expenditure by Telecom Industry

(Million US $)

Country	1985	1986	1987	1988
India (Public Sector Firms)	10.90 (0.2)	12.06 (0.20)	14.86 (0.20)	NA
India (Private Firms)	0.8 (1.3)	1.1 (1.27)	1.29 (1.42)	NA
USA	2925 (4.3)	NA	2909 (5.5)	3127 (5.7)
Japan	8813 (4.6)	8502 (5.3)	9361 (5.6)	NA

Note: Figures in brackets are R&D expenditure as a per cent of sales.

Table 5 gives the R & D expenditure for telecom at industry level in selected countries.[132] The expenditure on R & D by the Indian firms is nominal in actual terms, though in percentage terms they are similar in the two public sector firms, as can be seen from Table 2 and 3.

The telecom industry consists of two mutually exclusive, yet highly dependent parts, namely-(a) telecom-equipment industry; and (b) telecom services.[133] The telecom equipment industry is a high technology industry and developments in telecom industry are determined by what is happening in the developed world. Some of the major firms manufacturing equipment for both defence and civilian use are ATT, IBM, GTE, Lateral, Northern Telecom, Ericsson, NEC, Fujitsu, Philips, GEC, Plassey, Siemens and Alcatel. The industry is oligopolistic, but has a highly concentrated national structure. Four firm concentrations were around 70 percent in the mid eighties.[134]

The rank of various firms in the telecom equipment industry is given in Table 6.[135]

132. R & D Indicators AIST, (Tokyo.) 1988.
Dept. of Science & Technology, R & D Industry (New Delhi, 1988).

133. T. Sarkar, ''Global Changes and Local Adjustment''. Telematics, vol.3, no.6, pp. 68-73, 1990.

134. I.Sarkar, Switching, Telematics, vol.3, no.7, 1990, p.63-68.

135. Telecom Industry, EEC (1984), p.251.

TABLE 6

Rank on Year 1973 to 1986 for Front Ranking Firms in TEI (World)

Name of the Firm	1973	1976	1977	1978	1980	1981	1982	1983	1984	1985	1986
AT&T	1	1	1	1	1	1	1	1	1	1	1a
ITT	2	2	2	2	2	2	2	2	2	2	
Siemens	3	3	3	3	3	3	3	3	3	3	3b
Ericsson	4	4	4	4	5	4	4	4	5	9	8
GTE	6	5	5	5	4	6	5	10	10	12	
Northern Telecom	7	6	6	7	8	8	7	6	4	4	5
NEC	9	7	7	8	7	8	7	7	5	4	
Philips	8	8	8	9	9	10	10	12	12	12	10
CGE		9	9	12	6	5	6	5	8	7	2c
Thomson	5	10	10	6	11						
Plessey	10	12	12	18	11	11	11	13	14	14	13
IBM								10	9	6	6
Motorola				11							7
GEC	11	11	11	13	10	9	9	11	11	11	11
Fujitsu				19	12	13	12	14	13	13	9

Notes: a) AT&T Technologies after divestiture. Before that its name was Western Electric. Since it was an integral part of AT&T we wrote AT&T instead of WE.
b) Include GTE's 1986's equipment sale except for US switches, and Customer's premises equipments.
c) Combined equipment sale of ITT and CGE.

Table 7 shows that the switching market is highly concentrated.[136] The top 12 firms produce 99 percent of the output, but there is a tendency towards market saturation in the developed country market especially electronic switching systems (ESS) and EPABX.

TABLE 7

Concentration in Swtiching Market (%)

Criteria	1976	1982	1985	1986
Sales				
1st 12 firms	70	72	99	
1st 6 firms		54	70	
Lines controlled				
1st 8 firms	89		94	95

136. Op.cit.

Switching technology is going more and more digital for reason of speed and efficient call handling, adaptiveness and added on services easily facilitated. This uses high bandwidth using optical fibre, which is replacing old electromechanical types.[137]

The share of various digital switching technology equipment in the world is shown in Table 8.[138] This indicates that the market is oligopolistic and technology is closely held by large multinationals. This makes it difficult for developing countries to acquire the digital switching technology, without paying a part of the development cost.

TABLE 8

Switching Systems Used Currently

System	Firm	Home Country	No. of Countries in which in Operation or Order	No. of Lines in Millions in Operation or Order				
				Home Country	(%) of Total	Other Countries	(% of Total)	Total
DMS	NORTHERN	Canada	24	24.1	(81)	2.6	(13)	27.7
5-ESS	AT&T	US	9	18.6	(67)	9.0	(33)	27.6
E-10-B	Alcatel	France	57	19.9	(77)	5.6	(23)	25.4
AXE	Ericsson	Sweden	71	2.2	(10)	20.7	(90)	22.9
ESWD	Siemens	FRG	30	0.8	(10)	7.6	(90)	8.4
1240	ITT-BIM SEL	Belgium	21	1.4	(17)	6.9	(83)	8.3
NEAX	NEC	Japan	43	—	(0)	3.2	(100)	8.2
X	GES-Plessey	UK	4	7.9	(99)	0.1	(1)	8.0
FETEX	FUJITSU	Japan	13	—	(0)	2.7	(100)	2.7
FRXD	Philips	Holland	—	4	(73)	1.5	(27)	5.5

Note: For home market, Japan uses its own standard equipment D-70 produced by a number of Japanese manufacturers.

R & D expenditure incurred by some of the major firms for developing the digital switching technology is given in Table 9.[139]

R&D Costs for Developing Digital Switching Technology

Manufacturing Firm	R&D Costs (Billion US $)
E10 and E 12 (Alcatel)	1.0
DMS (Nothern Telecom)	0.7
AXE (Ericsson)	0.5
System 12 (ITT)	1.5
System X (GEC/Plessey)	1.4
ESS-5 (Western Elec)	0.75
ESW-D (Siemens)	0.7

137. T.S. Subramanian, "Telecom in Aid of National Development". National Seminar on Telecom. (New Delhi: FICCI.) 19-20 October 1983, p.8.

138. Telematics India, April 1990.

139. T. Sarkar, "Switching". Telematics, vol.3, no.7, 1990, pp.63-8.

Table 10 presents the telecom industry output of selected countries.[140] It shows that the Indian telecom industry is very small compared to that of other countries.

TABLE 10

Telecom Industry Output of Selected Countries

(Million US$)

Country	1986 Telecom Output	1986 Electronics Industry output	1987 Telecom Output	1987 Electronics Industry Output	1988 Telecom Output	1988 Electronics Industry Output
Belgium	269	1720	326	2020	341	2304
		(15.6)		(16.1)		(14.8)
France	4,050	21,399	4,689	25,407	4,698	26,010
		(18.9)		(18.4)		(18.1)
Italy	2,175	12,308	2.723	14,569	3,207	17,277
		(17.7)		(18.7)		(18.6)
Netherlands	567	6,305	751	7579	773	7,512
		(9.0)	(9.9)	(10.2)		
Sweden	1,421	4,565	1,380	4,864	1,683	5,680
		(31.1)	(28.4)	(29.6)		
United Kingdom	2,506	19,847	2,505	24,380	3,271	28,836
		(12.6)	(10.3)	(11.3)		
West Germany	3,981	31,515	4806	38,083	4,945	40,787
		(12.6)	(12.6)	(12.1)		
Brazil	541	5489	1,020	8,880	1,207	9,520
		(9.8)	(11.5)	(12.7)		
Canada	1,391	4,911	1451	5,695	1,650	6,616
		(28.3)	(25.5)	(24.9)		
Hongkong	364	4,262	348	5,366	411	6,928
		(8.5)	(6.5)	(5.9)		
Japan	8,670	1,23,843	11,497	149,979	14,727	187,422
		(7.0)	(7.7)	(7.8)		
India	297	2,387	363	3283	410	4,039
		(12.4)	(11.0)	(10.1)		
Singapore	139	5,403	149	7,543	245	10,652
		(2.6)	(1.9)	(2.3)		
South Korea	845	9177	1183	13,612	1,380	18,944
		(9.2)	(8.7)	(7.3)		
Taiwan	652	7677	887	11,604	927	13,764
		(8.5)	(7.6)	(6.7)		
USA	15,825	1,78,995	16429	1,87,873	16,751	2,01,728
Total of major countries	47,464	4,62,573	55,472	5,39,912	62,501	6,20,960
		(10.3)	(10.3)	(10.1)		

Note: Figures in brackets indicate share of computer industry output in electronics industry output as percentage.

140. <u>Electronics Information & Planning</u>, (Electronics Commission, New Delhi) Feb. 1991. p. 226.

Table 11 presents the magnitude of telecom equipment exports of selected countries.[141] It is evident that Indian telecom exports are not just low but minimal compared to the developed countries and the Asian countries such as Korea, Singapore, Hong Kong and Taiwan. Further, the vastness of exports gives a fairly good indication of the potential of the telecom sector in world trade.

TABLE 11

Telecom Exports of Selected Countries

(Million US$)

Country	1986	1987	1988
Belgium	336	418	315
France	482	552	605
Italy	219	254	261
Netherlands	172	274	299
Sweden	969	945	1,250
United Kingdom	321	390	473
West Germany	937	1,312	1,267
Brazil	45	51	43
Canada	532	579	609
Hongkong	423	530	657
Japan	2,343	3,331	5,148
India	2	2	1
Singapore	114	150	335
South Korea	270	457	567
Taiwan	423	473	494
USA	1881	2,175	2,711
Total for major countries	10,201	12,861	16,210

The Indian Context: Considering the importance of tele-communications, the Government of India has increased its investments in the telecom sector. In the 1978-79, there were only 1.86 million direct exchange lines whereas this number increased to 4.74 million direct exchange lines in 1987-88.[142] During 1987-88, 0.3 million net new connections were provided. The capital investments for developing public telecom system have increased.[143] In 1978-79, the total investment in telecom network was

141. Ibid.

142. Ibid.

143. Ibid. p. 227.

Rs. 16,602 million. This cumulative investment had gone up to Rs. 77,429 million by 1987-88.[144]

Inspite of this large increase in investments, there has been an increase in the number of persons waiting for telephones. During 1978-79, the waiting list for new telephones was 0.243 million. By 1987-88, this number had gone upto 1.28 million.[145]

Table 12 gives the number of telephones connected to the Departmental telecom network indicating a rapid expansion of the network.[146]

TABLE 12

Number of Telephones in India

Category	1950-51	1970-71	1985-86	1987-88
Number of Telephones (Million)	0.168	1.29	4.04	4.74

The numbers of telephone exchanges (PBAX) in operation in India are given in Table 13.[147]

Till 1986, telecom equipment manufacturing was restricted to the public sector firms. The Government of India subsequently deregulated a part of the indus-

TABLE 13

Number of Telephone Exchanges in Operation

Category	1950-51	1970-71	1985-86	1987-88
Departmental Telephone Exchanges	507	3,967	11,478	12,971
Extra Departmental Exchanges	147	936	NIL	NIL
Private Exchanges	3,033	13,685	26,191	25,365

144. Ibid.

145. Ibid.

146. Statistical Abstracts, Central Statistical Organisation, Calcutta, 1988.

147. Annual Report 1987-88, Dept. of Telecommunications, (New Delhi).

try. To give a boost to telecom development, a Telecom Commission was set up in 1988-89. The commission has set a target of 20 million telephone connections by the year 2000 as shown in Table 14.[148]

. Perspective Plan for Telecom for 2000 AD

	1995	2000 AD
Direct Exchange Lines (millions)	9.5	20
Telex (Thousands)	100	200
Villages with RAX (Thousands)	100	600
Public Call Offices in Urban Areas (Thousands)	200	1,000
Voice/Data Connections for Business (Thousands)	100	800

The alarmingly low density of telephone connections per 100 population points to India as one of the lowest. Table 15[149] and Table 16[150] show the status of India in this regard. The number of telephones in India has grown from about 0.8 lakhs

Table 1[illegible] : Telephone Connections in Selected Countries (in millions)

Country	1975	1986
Brazil	3.08	12.19
China	3.41	7.06
France	13.92	34.34
FRG	19.60	39.12
India	1.74	4.05
Japan	39.40	66.63
Korea	1.40	9.28
Malaysia	0.29	1.38
USSR	16.94	31.10
UK	20.34	9.51
USA	149.01	180.42

: Telephone Density in Selected Countries (Number per 100 inhabitants)

Country	1975	1988
Brazil	2.9	5.6
China	—	0.7
France	26.4	43.9
FRG	31.[illegible]	45.1
India	0.3	0.5
Japan	35.4	40.3
Korea	4.0	20.9
Malaysia	2.5	6.8
USSR	6.6	9.9
United Kingdom	36.4	40.9
USA	68.6	51.9

148. A.P. Raman High Tech. Gift of Pitroda. Business World. (Bombay) pp.30-41. Sept. 14-27, 1987.

149. U.N. Statistical Year Book. (New York.) 1988.

150. A Profile of the Worldwide Telecommunications Industry 1990. (Oxford:) Elsevier Advanced Technology, 1990. p.40

in 1947 to nearly 30 lakhs in 1983, or a 30 fold increase in 35 years,[151] which is good but not good enough.

The anticipated telephone connections in India by the year 1995 may be about 9.5 million. The target of 20 million has been set so that India can have a telephone density of 2 connections per 100 Indians.[152] It also planned to extend the telephone network to rural areas and to those in the urban sector who cannot afford telephones.

With this objective in mind, by 2000 A.D. one million pay phones ought to be established. This will mean at least one pay telephone in every village. The commission also stated that before the turn of the century, India will have a comprehensive voice and data network compatible with similar networks which are operational around the world, namely ISDN.[153]

The target of 20 million direct exchange lines is an optimistic target and will need substantial increase in the required infrastructure, definitely meaning additional investment. In the Indian telecom sector, there is both limited infrastructure and problem of management.[154]

While the merits of telecom are realised in a general way, such realisation is not reflected in terms of the financial outlays made for the telecom sector (Table 17).[155]

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151. T.S. Subramanian, Ibid., n.137, p.5

152. Telecom A Need to Review: B.K. Modi, Chairman Expert Committee on Elect. & Telecom. Manufacturing Association of Information Technology, N.Delhi, Jan.8, 1991.

153. Telecom: Keeping the Customer Satisfied, World Look, p.64.

154. A.K. Jain, President, FICCI, Inaugural Session of the National Seminar on Telecom, N.Delhi, Oct.1983,p.4.

155. Telecom 6th Plan (Ministry of Communications, New Delhi), 1989 taken from Manufacturer Association of Information Technology (MAIT).

Table 17

Plan outlay for the Telecommunication and physical achievement during successive Plans

Items	Unit	1st Plan 51-56 actual	2nd Plan 56-61 actual	3rd Plan 61-66 actual	Annual Plans 66-69 actual	4th Plan 69-74 actual	5th Plan 74-78 actual	Annual Plans 78-80	6th Plan 80-85 Plan	7th Plan 85-90 Plan
Plan outlay	Rs. crores	47	66	164	159	415	781	567	2950	12500
Local exchange	No.	291	543	1337	721	1272	1527	1192		
Local exchange capacity	Lakh lines	1.16	1.74	3.59	2.61	4.44	5.40	3.19	15.60	54.4
Working connection (DEL's)	Lakh lines	0.53	1.59	3.19	1.63	4.30	4.83	2.89	14.00	37.50
Telephone sets	Lakh lines	1.09	1.88	4.16	1.92	5.64	6.10	3.69	18.20	48.75
Long distance PCO's	No.	918	651	430	674	1998	3721	5100	6170	25000
Manual trunk boards	No.	185	375	1098	1014	1811	1601	668	2500	
Trunk automatic exchanges (TAX's)	No.	-	-	-	2	2	13	1	40	
Tax capacity	No. of lines	-	-	-	3500	3600	23350	9850	112040	298000
STD routes	No.	-	1	10	7	29	71	23	60	
Long distance speech channels	No.	353	823	3966	5604	13382	22375	11104		
Coaxial cable system & other trunk cables	Route kms.	-	734	5190	2371	4538	4049	2996	13000	37125

Items	Unit	1st Plan 51-56 actual	2nd Plan 56-61 actual	3rd Plan 61-66 actual	Annual Plans 66-69 actual	4th Plan 69-74 actual	5th Plan 74-78 actual	Annual Plans 78-80	6th Plan 80-85 Plan	7th Plan 85-9 Plan
Microwave systems	Route kms.	-	-	190	2080	2378	8627	3770	17000	3000
Public telegraph offices	No.	1550	1817	1803	1643	2062	5418	6552	20000	2500
Telex ex-changes	No.	-	-	12	13	24	52	35	100	
Telex change capacity	No.	-	-	1600	4360	6480	7425	2150	35500	5500
Telex sub-scriber's lines	No.	-	-	995	2322	5167	6157	3342	18300	
VFT channels	No.	130	170	2799	2706	2643	5347	3462	7000	
Telephones?	No.	536	344	2530	6737	10000	9240	6681		

As a result, the telecom sector is left to compete with other sectors for a place in the order of priorities. It is also well known that integration of accounts of Posts & Telegraphs has resulted in giving a wrong picture of the revenue generated by telecom services.[156]

After all, telecom can be viewed from another angle: As resources are finite and depletable, available resources should be utilised in the best possible manner and maximised to step up productivity in other sectors. Since telecom can help other sectors in productivity, it is essential to give it its due and make it a commercially viable proposition. It is in the interest of the government and the country to maximise

156. Op.cit.

investment in this field.[157]

Of the proposed target of 20 million lines to be achieved by 2000 A.D., the addition per annum has to be 1.5 million, which is five times the existing rate of addition. This will need substantial investment in switching technology equipment manufacturing.[158] The present capacity of switching equipment manufactures is grossly inadequate to meet the demand and the present capacity of 40,000 lines of stronger, 300,000 lines of crossbar and 300,000 lines of digital exchanges is with Indian Telephone Industries (ITI), a public sector firm.[159]

In actuality, switching is the major thrust area towards goal achievement and, therefore, the replacement of electro-mechanical lines should take place.

The Department of Telecom purchase budget telecom equipment according to the 8th Plan 1990-95:[160]

A.	Switching	Rs. 6,996	crores.
B.	Transmission	Rs. 3,650	crores
C.	Cables	Rs. 4,740	crores
D.	Terminal Equipment	Rs. 2,194	crores
E.	Ancillary Products	Rs. 690	crores
	Total Rs.	18,270	crores.

157. A.K.Jain p.5. in Papers on Conference on Telecommunications in FICCI. New Delhi. September 1983.

158. B.K. Modi. Chairman Expert Committee on Electronics & Comm. ASSOCHAM. "Telecom: Need to Review". 8 January 1991. New Delhi.

159. ITI Annual Report. 1987-88.

160. Dept. of Telecom. (Ministry of Communications. New Delhi 1990).

The capital investment for the manufacture of Telecom Equipment for the Eight Plan being a total of Rs. 2,200 crores with the foreign exchange component of Rs. 788 crores, it is a large investment and may change the entire telecom sector.

The likely imbalance in the production capacity has to be surveyed and rectified (for the period of 8th Plan, 1990-95):[161]

Item	**Required**	**Production capacity**	**Imbalance**
Cables	750 lacs km	1100.0 lacs km	350.00 lacs km
—Co-anials			
—Jelly filled			
Fibre Optic	2.5 lacs km	6.0 lacs km	3.5 lacs km
Electronic Switch	75.0 lacs lines	25.0 lacs lines	50.0 lac lines

The expenditure budget of telecom equipment worth 18,000 crores need not come from the exchequer's money. The total requirement can be funded as follows:[162]

— Deposits from subscribers;

— Internal accruals of DOT and MTNL;

— Deposits through Public Bonds;

— Direct Purchase by subscribers; and

— Leasing of Equipment by subscribers.

Again, capital investment can be rationalised by augmenting the electronic switching

161. Ibid.

162. B.K. Modi. Ibid., n.158

capacity in the private sector[163] (which has now been mooted)[164] and by permitting foreign technology and investment so as to avoid a burden on the government for foreign exchange as well as for capital investment. Yet there is a major argument against imports, especially switching technology.[165] The issue here seems to be that imports would lessen self reliance.

Another alternative would be to keep this on a two-track level i.e. import only the essential and the needed and indigenise all that can be.

All this was in consonance with the strategy proposed in the Seventh Five Year Plan of Government of India.[166] The strategy proposed for the Telecom for 1985-90 by the Planning Commission was:

1. Balanced growth in network;
2. Rapid modernization;
3. Quantum jump in technology;
4. Increased productivity; and
5. Innovations in organizations and management.

Keeping these objectives in view, digital switching technology was identified as the thrust area by the Telecom Commission.

Also ''Mission Better Communications'' launched in April 1986 as one of the

163. Om Wadhwa. ''Private Sector Participation in Telecom Development'': National Seminar on Telecom. (New Delhi) 19-20 October 1983. p.2.

164. Times of India. Feb. 8. 1991.

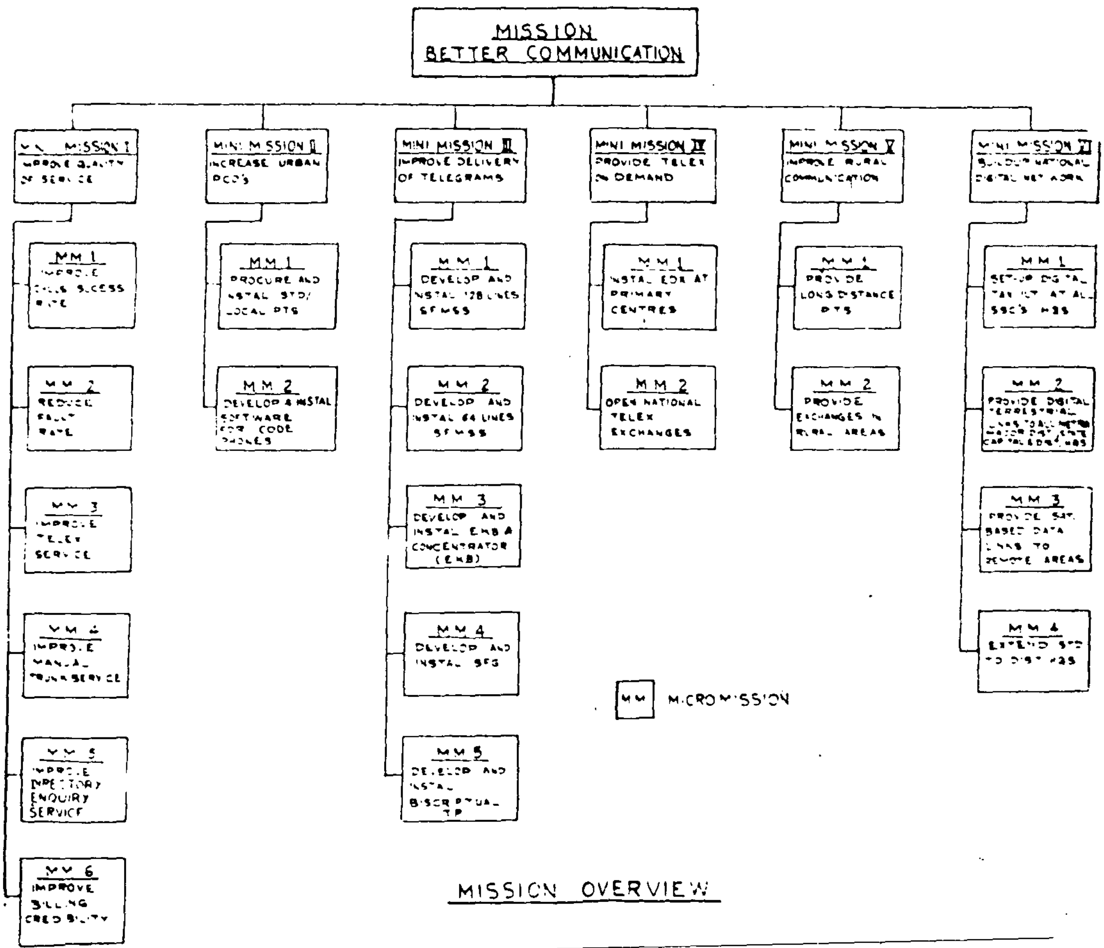
165. Balraj Mehta. ''Battle for self Reliance in Telecom''. Economic & Political Weekly. 26 Aug. 1989. p.1942.

166. Planning Commission. Seventh Five Year Plan. New Delhi. vol.2. 1985.

five national missions is of vital importance.[167] The Department of Telecom, its officers and staff at all levels dedicated themselves to work whole-heartedly with commitment, devotion and a sense of mission to give the nation a continuously improving telecommunication service. Attention within "Mission Better Communications" will be focussed on six Mini Missions, viz., (for the time period January 1988 to March 1990).

(Fig.2)[168]

NATIONAL MISSION ON TELECOMMUNICATIONS



167. "National Mission on Telecom 1987-1990", Jan. 1988, p.5. Dept. of Telecom, Govt., of India.

168. Ibid.

(a) Improve quality of service;

(b) Increase urban PCOs;

(c) Improve delivery of telegrams;

(d) Provide telex on demand;

(e) Improve rural communications; and

(f) Build up a national digital network.

Due to pregnent changes in the government in the past few years, these programmes were not followed carefully. Nevertheless, there has been a change insofar as motivating the telecom sector towards greater efficiency.

It is, again, a fact that during the Seventh Five Year Plan (1985-90), the annual growth in this sector has been averaging 28 percent.[169] In 1985, the total telecommunications equipment and service market was $950 million, $400 million of which consisted of imports. By 1987, the market had grown to $1275 million, with imports at $52.5 million. Total imports are projected at $2 billion during 1988-1990.[170]

The U.S. accounts for approximately 15 percent of India's telecom imports behind Japan and France with 35 percent and 17 percent respectively.[171] There is

(1990-1995) while the private sector may grow to as large as a $6 billion market.[172]

Collaborations such as joint ventures, licensing agreements and technology transfers are preferred. Much of the transfer of technology takes place through firms, joint ventures, collaborations, licensing and training the educators and at the educational institutions.

Imports are not permitted to be held in inventory, so foreign firms must have contracts with end users. With the recent (1991) policy changes, this will be somewhat different.

The best sales prospects for U.S. business include customs maintenance systems, satellite systems, digital microwave transmission equipment, data communications, PBXs and components technologies.[173]

Statistical Data[174] (Millions of U.S. Dollars)

	1985	1986	1987
Imports	400	500	525
Domestic Production	575	685	795
Less Exports	25	35	45
Total Market	950	1150	1275
Import from U.S.	50	70	80

172. Ibid.

173. Ibid.

174. Ibid.

It is evident that India's imports in the telecom sector have been increasing and, definitely, the U.S. is one of the foremost nations India is importing from.

There have been detailed discussions and tabled information in the Indian Parliament on telecom imports, manufactures including in public sector units and collaborations.[175]

With so many elaborate procedures of transferring of technology, it is not possible to gauge exact costs nor project the exact volumes.

While indigenous technology is developing slowly, the greatest demand in collaboration has been in switching, transmission, user terminals and modems.

Options before India: The former Prime Minister Rajiv Gandhi gave a major thrust to telecommunications development in India through his controversial friend Satyen G. (''Sam'') Pitroda, instrumental in establishing the Centre for Development of Telematics (C-DOT), perhaps the second milestone after ITI.[176]

The controversy swathing C-Dot, whether it delivered its products according to schedule or not is not the issue here nor is it required to be gone into for the purpose of this argument. Neither is the criticism of ITI valid. The issue today is whether India should wait till these organisations come of age and start delivering, or go ahead and sign collaboration agreements with major foreign providers, develop telecommunications services in the country, and provide enough lead time to ITI and C-DOT to develop.[177]

175. Lok Sabha Starred Q.No.164, 29 July 1986.
Lok Sabha Starred Q.No.307, 10 December 1985.

176. Arun Bhattacharjee, ''Telecom Forge Alliances of Bust'', Telematics India, vol.3, no.20, July 1990, p.45.

177. Ibid.

In this regard, the former Chairman and Managing Director of Videsh Sanchar Nigam Limited (VSNL), T.H. Chowdary, observes: "there is no sense postponing improvements, new facilities and new services until we invent new technologies, that way the gap between us and the developed countries would increase. We should forge strategic alliances with willing leading companies of the world.... We must have the latest technology collaborations and try to have strength in a variety of transmission equipment, in cellular radio, in optical fiber equipment and terminal devices. Our country is big enough, our needs are huge and we can sustain more than one technology".[178]

The international telecom companies think alike. Most of them believe that India has the capacity to sustain parallel services. Their perception is that the value of telecom growth is poor in India, divided between the technocrats and bureaucrats.

Self reliance in telecom is a myth right now. Telecom development will have to be at parallel levels, import only as necessary and indigenise alongside.

Thailand and South Korea protect their component industry as a rationale for import substitution strategy. This makes sense to them only if done in a selective and time-bound manner, not across the board and not indefinitely.[179]

Enquiries reveal that option for new value added services in communication does not necessarily mean outflow of foreign exchange, nor is it a drain on the economy of the country e.g., Thailand is getting new services from a major international provider without spending a penny. The agreement is to reimburse 5 per cent as royalty and

178. Ibid.

179. Times of India, 13 August 1991.

operating charges, normal in international trade practice.[180]

A recent study by the FICCI states that large MNCs are unwilling to invest in India because the conditions for technology transfer, including indigenisation stipulation, buy back or export obligation, royalty terms and lack of intellectual property protection are constraints to investment in India.[181]

Another major problem of Indian telecom sector is the underutilization of capacity. Indian Telephone Industries have a production capacity of 1.05 million but the Department of Telecommunications can hardly place orders for 1 million annually.[182] Policy makers really ought to have thought before creating 5 times more capacity in the country. The low demand is not because of any lack of demand from the people but the inability of network managers to provide the system.[183]

Most of the telecom equipment is imported or got through technological transfer. Even so, ITI spends 3 percent of its sales on R & D but finds phasing out of old equipment critical over the next two to three years.[184] Rs.600 crores is based on indigenous production[185] Yet, Indian industries do not come up to the required level where components are concerned. This further creates lags in demand and supply. As earlier stated, collaborative agreements try to make up for this. There has also to be more emphasis on microelectronics in the telecom sector.

Microelectronics in India: The VLSI technology transfer has been started by

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180. Op-cit.

181. Ibid.

182. Ibid.

183. Telematics India, vol.3, no.10, July 1990, p.47.

184. Interview with U.D.N. Rao. Chairman ITI, 28 June 1991.

185. Ibid.

the ITI with the U.S. firm ARCUS in 1988 in a two phase implementation, the first costing Rs.20 crores and the second Rs.30 crores. It is expected to meet 25 percent of ITI's demand for the production of ASICs.[186]

This was primarily done because the future of the semiconductor complex was still uncertain after the fire, which meant that India's dependence on exports had substantially increased. In 1990, ASICS worth Rs.100 crores are being imported from the U.S. and Japan. The proposed VLSI project was primarily low and self reliant.[187]

What is needed by ITI even more is R & D in micro electronics because: a) it improves quality; b) cuts costs; c) is fuel efficient; d) non-pollutant; e) safe. Any investment in micro-electronics will be well worth it.[188]

Micro-electronics in telecom technology is not just a "fancy" technology. It is possibility of power at low cost, according to A. Prabhakar, ITI Executive Director, 'Micro-electroics'. He felt that India was a decade behind the Asian Giants in this legend but was motivated to catch up within a year if VLSI was treated as an option and microelectronics manufacture begun. He also felt that the decision should not be postponed. Further, that it was well worth the price for VLSI transfer of technology cost and pricing. But, of course, micro-electronics technology has to the export-import related or else it will not develop.[189]

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186. Computers Today. vol.6. no.63. May 1990. p.9.

187. Ibid.

188. Interview with A. Prabhakar. Executive Director. Micro-Electronics Div.. ITI. 5 July 1991.

189. Ibid.

Moreover, the Semiconductor Complex Ltd. (SCL) at Chandigarh is beginning to revive after the devastating fire on 7 February 1989.[190] This resurgence is not due to any change in thinking or work culture in the organisation but the appointment of a permanent chief executive.

He is planning to rehabilitate the complex in two phases and his plan is to opt for maximum utilisation of this complex. This would then resolve a lot of the nation's electronics problem.

Microelectronics technology contributes to globalization and shaping of world economy. The microelectronics-based technological revolution plays a fundamental role in accelerating and strengthening the internationalisation of national economies.[191] It provides the infrastructure without which such a process could never take place. The role of telecommunications especially is important in this regard, to integrate and make possible the unified management of spatially distant activities. In addition, new transportation technologies, much dependent on information processing for their effective operation, ensure a constant flow of commodities throughout the world.[192]

The positions of individual national economics and business firms in the new international system depend increasingly on their positions in the technological division of labour.[193] High-technology markets, particularly in electronics, are the fastest

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190. Times of India, 25 August1991.

191. Manuel Castells, and Tyson, "Growing Impact of the Technological Revolution", Impact no.70, 1990.

192. Ibid.

193. Ibid.

growing sectors in the international economy, and performance in those markets is often a decisive element in overall economic growth.

Of course, even more important for international competitiveness is the ability of countries and firms to use high-technology processes in the production and management of traditional industries.

New technologies have constituted a powerful instrument in restructuring process insofar as they have enabled productivity gains without corresponding increases in employment and labour costs and have opened up new markets, particularly in high technology defense industries.[194] ITI transfers important telecom technology to Bharat Electronics Limited (BEL) for defence purposes.[195]

Therefore, it becomes even more important to trace and project the profile of Indian electronics of which both telecommunications and computers are integral parts. N. Seshagiri calls it "compunication" in which he outlines the emerging technology as that of the ISDN. He merged communications and computers and felt the future lay in both of these.[196]

Some time ago, leading communication exports in the U.S. estimated that it would take an investment of $ 16 million a year over 30 year period for developing countries to bring their communication to the U.S. level.

Meanwhile, the U.S. telecommunications regime continues to expand.[197] Since

194. Ibid. p.19.

195. ITI Annual Report. 1988-89.

196. Telematics India. vol.4. no.6. March 1981. p.26.

197. Infotek. vol.4. no.5. Feb. 1991. p.56.

the gap cannot be bridged except at very high cost, it is more viable for nations like India to prioritise on aspects and segments of telecommunication, focus on them and develop operational areas. In this way, the lag will not seem unnaturally large.

Competition among producers from the developed countries encouraged a scramble amongst them for new markets. This scramble, alongwith the rapid pace of technological breakthrough and introducing of state-of-the-art technologies, caused dramatic declines in the prices of semiconductors computers, and other electronic equipment to the benefit of all users, including those in developing countries.[198] Moreover, market pressure makes it difficult for firms to avoid the temptation of licensing their best technologies (inspite of wanting to protect their intellectual property), in order to gain an edge over their competitors. Thus, producers seem willing to make deals that could be advantageous for developing countries with large potential markets and for producers in developing countries, so far now especially in East Asia.[199] However, with Indian changes in foreign investment policies linked with productivity and technological development enclosed in political stability, this scenario may change for the better as far as India is concerned.

Unfortunately, current competitive dynamics in high technology industries encourage a strategy of locating close to major markets, and major markets remain overwhelmingly within the developed countries.[200]

But now, more and more as a result of competition among producers in the developed countries, locating production in certain developing countries has worked

198. Impact, no.70, 1990, p.23
199. Ibid.
200. Op-cit.

out as an attractive competitive strategy, as these offer inexpensive engineering talent; cheap components, a supportive infrastructure, tax, and regulatory environment, and the possibility of out-manoeuvering northern competitors from third-country platforms.[201]

Table 18 shows electronic production in India from 1989-90.[202] It shows a steady rise in production in electronic equipment and components.

Production in Electronic Equipment and Components

(Rs. in Million)

Item	1985	1986	1987	1988	1989
1. Consumer Electronics	10,300	12,750	18,200	24,000	28,000
2. Industrial Electronics	4,040	5,250	6,850	9,350	12,100
3. Computers	1,550	2,800	3,750	4,860	7,000
4. Communications and Broadcasting	3,800	5,040	7,100	9,000	14,250
5. Strategic Electronics	1,960	2,220	3,000	3,900	5,000
6. Electronics Components	4,100	5,100	7,000	10,250	14,400
7. Export Processing Zones	850	1,440	1,300	1,640	2,250
Total	**26,600**	**34,600**	**47,200**	**63,000**	**83,000**

Table 19 shows the export of electronic items.[203] This shows rise in export of

Sectoral Breakdown of Export of Electronic Items

(Value: Rs. Million)

Item	1985	1986	1987	1988	1989
1. Consumer Electronics	140	180	303	477	570
2. Industrial Electronics	235	645	640	520	860
3. Computers	345	376	407	1,378	2,430
4. Communications and Broadcasting	5	72	105	85	30
5. Electronic Components	480	637	960	1,280	2,290
6. Computer Software	340	490	705	1,010	1,570
Total	**1,545**	**2,400**	**3,120**	**4,750**	**7,750**

201. Ibid.

202. Dept. of Electronics Report. (Electronics Commission. New Delhi) 1990. p.66.

203. Ibid.

all electronic items. Table 20 shows the growth profile of the electronic industry.[204]

Electronic Growth Profit

Year	Production (Rs. Million)	Growth %agc
1984	18,900	39.0
1985	26,600	40.7
1986	34,600	30.1
1987	47,200	36.4
1988	63.000	33.5
1989	83,000	31.7

Conclusion

The demand for electronic products and systems is bound to rise in the coming years, and the industry will have a vital role in the overall development of the country's economy. Some of the prominent characteristics of the sector include increasingly high entry cost, high rate of obsolescence of technology, a requirement for trained manpower and ever changing market and distribution pattern.[205]

Obviously, the liberal import of capital equipment, raw material components, easing of restrictions on foreign collaborations, has not had the desired effect of producing price-competitive products. From 1985-90, 1187 foreign collaborations were approved by the Government in various sectors and annual payments to for-

204. Ibid.
205. Telematics India, vol.4, no.1, October 1990, p.24.

eign collaborators exceed Rs.5,000 million.[206] These include only direct remittances for technology transfer. Larger indirect payments were also made to the collaborators through the import of capital goods, assemblies, components, and technical services.

Import of technology has helped in the introduction of modern technologies in some sectors, but it has not succeeded in developing technological culture within India. R & D facilities as already observed continue to lag far behind global levels.[207] In this field where R & D is very necessary to prevent obsolescence, it is badly lacking.

In effect the Indian electronics and telecom sectors are at cross roads. On the one hand, there are virtually unlimited prospects of growth, while on the other there is a serious possibility of sections of the industry falling sick. On the one hand, India has demonstrated its ability to export quality manpower; on the other, the country's share of global trade has continuously fallen.

Not only do strategies have to change: a dual one of both importing and indigenising but also political will and implementation and projecting not mere rhetoric. This will further Indian aims in getting true transfer of technology in telecom, computers and other sectors and not just second line transfer merely to pacify immediate goals.

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206. Ibid, p.25.

207. Department of Science & Technology, Annual Report, 1989.

Chapter VI
SIEMENS
(Firm Analysis I)

Siemens is a West German private company, with a major interest in power generation, power transmission and distribution, automation, data and information systems, public and private communication systems, defence electronics, semiconductors, electromechanical components and many more related activities. Siemens' aim is to offer worldwide competition in the electrical and electronic market and be a pace setter for the advancement of technology.[1]

According to the corporate philosophy of Siemens, its endeavour is to provide customers throughout the world with products and services that offer at least minimum benefits; there is dedication to excellence; a desire to maintain constructive long-term relationships based on mutual trust with its partners the world over. Siemens' philosophy is also to see itself as a part of the national economies it serves and feels a strong sense of responsibility to society and the environment.[2]

In India: Siemens in India has played an active role in the techonological progress experienced in the last three decades. In the 1960s, India's expanding investment in power generation called for high quality switchgear and auxiliary equipment. Siemens presence in India grew out of a response to this need.[3] First, in a small way, it started with assembling switchboards at a workshop in Bombay. Later, it established manufacturing units in Bombay, Calcutta and Nashik. Siemens now manu-

1 Annual Report, Siemens 1990, p.1

2. Ibid.

3 Total Service from Siemens, Tata Press, 1989, p.2

factures a host of products for power engineering and automation systems, railway signalling systems, telecommunication networks and medical engineering.

Telecommunication equipment made to Siemens' design is used in the country's telephone and telex networks. Siemens has also centralized traffic control and automatic train control systems to ensure safe and efficient railroad operations. In medical engineering, Siemens has supplied advanced radiological and electromedical systems to various hospitals.[4] Siemens' involvement reflects the latest trends in electronic and electrical technology. Besides standard equipment, Siemens now provides state-of-the art instrumentation and controls for power stations and industries. With varied products, such as telecommunications equipment, medical electronics, switchgear, switchboards, drives, motor control, automation systems and railway signalling systems, Siemens is one of the firms which keeps India in the frontline of international technology.[5] Being in close contact with Siemens AG, West Germany, gives Siemens in India access to the world's latest developments in every field.

Technology Transfer

After the interviews, survey, and analysis of the company's activities, it was found that the technology transfer had taken place through the parent company in West Germany via its Indian subsidiary.

Costs: The costs of this technological transfer in the main are intangible. Its volume cannot be calculated as various packages are offered by Siemens AG, West Germany to Siemens in India in the areas mentioned before.

Motives: According to Siemens, India is a politically stable nation with a large

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4 Ibid.

5 Siemens in India, Tata Press Ltd., 1989, p.5

market. Increasing population presents a good option with qualified scientists and a number of engineers.[6] The motive of Siemens for technology transfer is purely profit and market-based and, therefore, it perceives its efficiency as related to these two factors. Hence, Siemens in India resorts to collaborations as with Cable Corporation of India Ltd., Bombay, with 31.2 per cent participation. Siemens Ltd. Bombay itself has 51 percent and Webel Telematik Ltd. has 49 per cent participation. This structure is presented in figure1.[7]

Due to both size and assets as well as 51 percent foreign equity participation, Siemens Ltd is considered an MRTP-FERA company and, therefore, requires government sanction by license, MRTP clearance and FERA approval. Fig.2 provides a visual explanation of Siemens reading of India's Industrial Policy.[8] These restrictive governmental practices have not helped smooth technology transfers mainly because of low profit and obstructions by the bureaucracy and red-tapeism.[9]

Corporate Structure: Siemens is headed by the Management Board under whom the Corporate Executive Committee functions. Hierarchically arranged below this are the groups, corporate divisions, central departments and centralized services. Apart from these there are special divisions, such as those of the audio and video systems and electromechanical components.[10]

Decision Making: This is vertical but efficient. Most of the flow of decisions is

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6 Siemens Company Files, 1989.

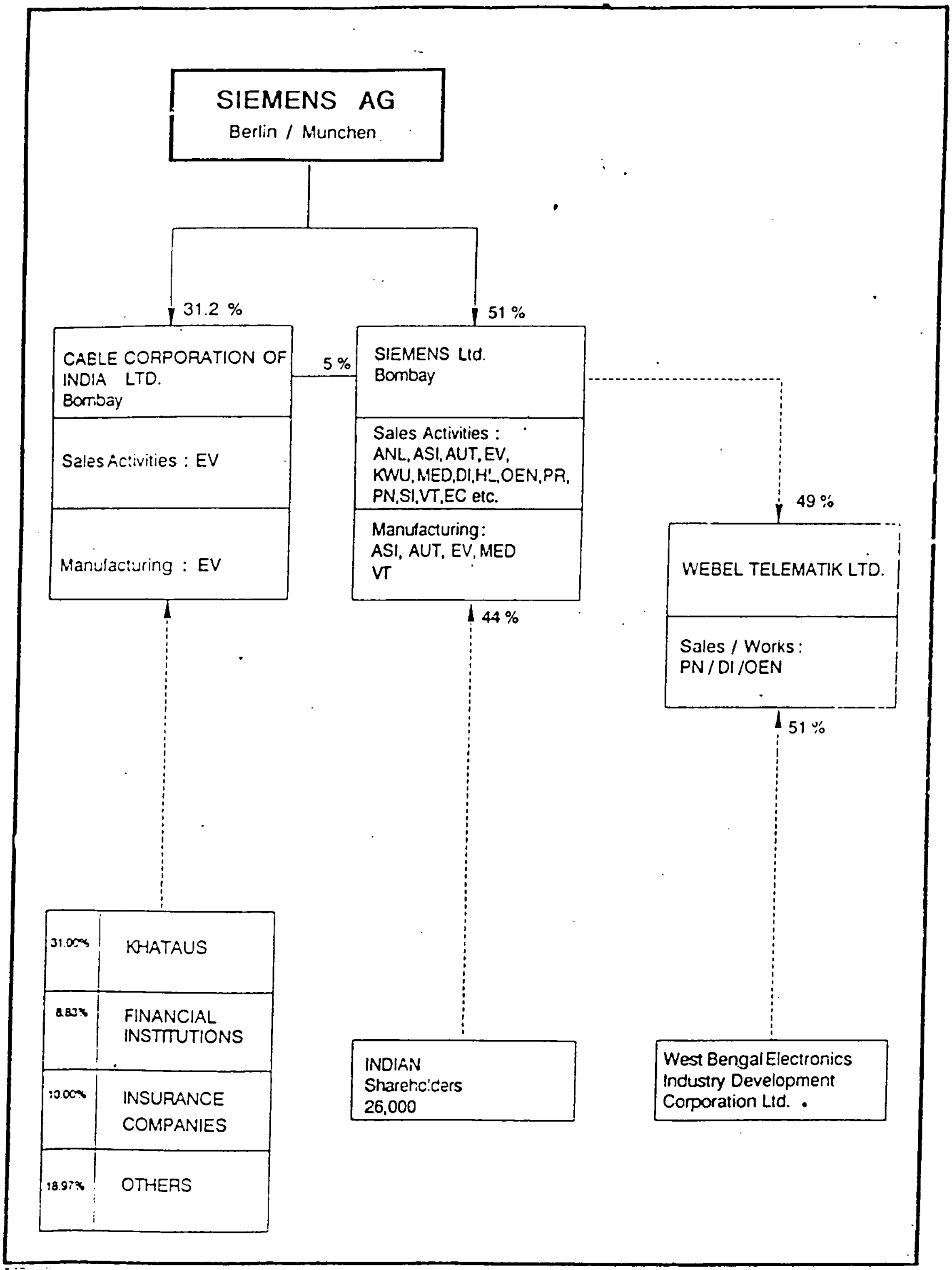
7 Siemens Corporate Office Files, 22 Dec. 1990.

8 Siemens Corporate Office Files, 11 Dec. 1990.

9 Lutz, Hoffman, The Transfer of Technology to India, FES, (New Delhi) November 1984, p.11. (Unpublished)

10 Annual Report Siemens 1990, p.14

Figure 1


SIEMENS AG
Berlin / Munchen
31.2 %
51 %
CABLE CORPORATION OF INDIA LTD.
Bombay
Sales Activities : EV
Manufacturing : EV
5 %
SIEMENS Ltd.
Bombay
Sales Activities :
ANL, ASI, AUT, EV,
KWU, MED, DI, HL, OEN, PR,
PN, SI, VT, EC etc.
Manufacturing :
ASI, AUT, EV, MED
VT
49 %
WEBEL TELEMATIK LTD.
Sales / Works :
PN / DI / OEN
44 %
51 %
31.00%
KHATAUS
8.83%
FINANCIAL INSTITUTIONS
10.00%
INSURANCE COMPANIES
18.97%
OTHERS
INDIAN
Shareholders
26,000
West Bengal Electronics
Industry Development
Corporation Ltd.

SIEMENS

Figure 2

INDUSTRIAL POLICY

India follows Joint Sector Economy.

Areas of Public and Private Sector are well defined.

National economy is planned every . years.

Industrial development regulated through Government Industrial Policy

Industries Development Regulation Act, 1951 IDRA	Monopolies & Restrictive Trade Practices Act, 1969 MRTP	Foreign Exchange Regulation Act. 1973 FERA
° To regulate industrial development	° To control economic power and to restrict monopolies within the Private Sector	° To control foreign exchange outgoing by regulating foreign companies with foreign equity > 40 %
° Licence required to manufacture 170 items	° Only 100 items out of 170 allowed for manufacture	° Only 100 items out of 170 allowed for manufacture
		° Restriction on local trading

Due to size (assets > Rp 1"0) and 51 % Foreign Equity Siemens Ltd. is considered a MRTP-and FERA-Company, therefore, requires Government sanction by licence, MRTP clearance and FERA approval.

In line with the current Industrial Policy

FOR NON-FERA/NON-MRTP COMPANIES NO LICENCE FOR ALL ITEMS EXCEPT - SI FIELD	EXEMPTIONS FOR MRTP COMPANIES FOR 75 ITEMS - SI FIELD	FERA COMPANIES ARE NOT PERMITTED IN - SI FIELD
° Telecom Equipment	° Electronic Components	° Industrial Electronics*
° Subscriber (end user) Communication Terminal Equipment	° Switchgear/Motors	° Consumer Electronics
° Wireless Equipment	° Computer & Peripherals	° Computers
° Computer Peripherals (excluding Keyboards & Monitors)	° Computer Software	° Communication
° Microprocessor based industrial control instrumentation systems	° Communication	° Control & Instrumentation*
	° Control & Instrumentation	
	° Industrial/Professional Electronics	

SUBJECT TO INVESTMENT/ BACKWARD AREA LOCATION RESTRICTIONS

NO LICENCE NECESSARY FOR MRTP/FERA COMPANIES FOR 70 ITEMS IF LOCATION IS CENTRALLY NOTIFIED BACKWARD AREA - SI FIELD

- Electronic Components
- Switchgear/Motors
- Power & Distribution Transformers
- Word Processors
- Surgical Instruments
- Scientific Instruments

within the framework of thecorporate philosophy and it is structurally possible to ensure quick decsions.

Research and Development: In a multinational type of firm as Siemens, R&D is a major factor in assessing technological progress and absorption. A five year summary analysis shows increasing R&D from 1985-86 to 1989-90 i.e. from DM 5,401 to DM, 6,980[11] though the same figures show a decline in the percentage of sales. The R & D set up of Siemens in India plays a key role in expediting the process of technology transfer and subsequen adaptations to meet specific requirements. In addition, emphasis is also on developing new applications for existing technology. [12] Siemens in India has a separate R & D set up with professionals drawn from various technological areas. It employs about 140 highly qualified and experienced professionals. Elaborate facilities have been established for Research and Development work on products and systems like motors, X-Ray, railway signalling and industrial electronic equipment.[13]

The activities of the R & D set up are in the areas of product development suited to Indian conditions, process development, product innovation, import substitution (though not good in all cases), upgradation of technology and technology exports.[14] From 1984-1989, R & D expenditure in India has been around three per cent of ex-factory value of Siemens production.[15] This does speak for Siemens' commitment to promote R & D within the organization, but there is scope for a

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11 Ibid. p.52-3.

12 Siemens Manufacture in India, (Bombay). 1989. p.21.

13. Ibid.

14 Ibid.

15 Ibid.

higher expenditure. The fact that it is not so is mainly due to the negative atmosphere of the Indian State or else, there could have been more break throughs. Siemens AG, West Germany spends about Rs.40 billion on research and development each year. In each area, Siemens' breakthroughs represent not just product developments, but frontier-level contribution to electrical and allied sciences. Siemens in India has direct access to this fund of knowledge and application know-how and is continuously finding ways and means of adapting it to the Indian context,[16] although not all its efforts have been successful.

Siemens' research and development efforts in India have resulted in products and systems that have contributed significantly to customer benefits in terms of costs and technology.[17] In the development of products, indigenous raw materials substitutes are constantly identified and incorporated. This ranges right from enhancing insulation properties to suit tropical conditions, to making product modifications, to interface with the systems used in Indian industry. In production, process modifications are incorporated to suit local conditions. Over the years, the innovative adaptation of materials and processes has enabled Siemens to develop and manufacture products and systems indigenously to international standards.[18] The Indian Government-recognized R & D set-up is committed to updating technology, development of new technologies and products, absorption of technology, product and process design, and productivity research for increasing efficiency.[19]

Technology Absorption: According to interviews held, it is found by Siemens'

16 Siemens in India, 1989, p.24.

17 Ibid.

18 Ibid, p.25.

19 Ibid.

managers that technology absorption, in spite of indigenous R & D, is relatively low. The Indian market needs, as far as industrial electronics are concerned, are met in about five to six years and the volume is as high as 90 per cent. Only one to two per cent is at a sophisticated level of technology.[20] India is not a big enough market for manufacturing electronic components . There is a need for it, but the Indian market is not lucrative enough. There are minor collaborations amongst Indian companies, but only about six to eight Indian major companies have picked up manufacturing.[21]

All this needs to change, but is possible only with a major changes in the Government of India's policies. This seems to be underway now. Since the 1991 budget the road has opened to industrial liberalization and major change in India's economic policies. Technological upgradation, an edge for foreign investors with 51 per cent equity, relaxed FERA regulations and delicensed sectors, may appear to be a mixed bag of policies but these will undoubtedly give a fillip to companies like Siemens.[22]

Electromechanical Components: In electromechanical components, Siemens has established a strong position in growth sectors, showing continued increases in the market shares of these components.[23] The Siemens' Berlin optical fibre components plant has received new orders marking an increase of nearly 50 per cent. Siemens was also instrumental in drafting the new FDDI (Fibre Distributed Data Interface) standard for applications in computer networks using high data transfer rates. A

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20 Interview, with Mr. Chaturvedi, Manager, Regional Sales, Siemens, Banaglore 24, June 1990.

21 Ibid.

22 Times of India, July 25, 1991.

23 Siemens Annual Report, 1990, p.26.

further impetus is seen in the growing use of electronics in automobiles. [24]

In India, the study team on electronic components constituted by the Working Group on Electronics for the Eighth Five Year Plan has submitted its report. The final report of Task Force on Electronic Components has also been submitted. The requirements of components by the terminal year of tje Eighth Plan, i.e., 1994-95, has been estimated to be Rs. 73,000 million. It has been estimated that approximately 75 per cent of the component demand will be met from local production and the target for component production for domestic consumption by 1994-95 is proposed to be Rs.55,000 million.[25] The components industry has shown encouraging results on the export front, and the availability of high capacity plants can further boost exports. Rs. 10,000 million has been during the Eighth Plan estimated for export. Therefore, there has been tremendous pressure to indigenize and raise the level of components production.[26] New investments will be needed in order to achieve this increase. Siemens had already had this on its worktable but the above figures have been debated as being ambitious. As profiled in the report, it is a 31.7 percent growth, but in real terms, the growth in indigenization of components is hardly four per cent.[27] (see Fig.3.).

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24 Ibid.

25 Department of Electronics Report. Government of India. 1989-90. p.11.

26. Ibid.

27. Ibid., p.7

Fig.3.

Year	Production (Rs. million)	Growth %
1984	18,900	39.0
1985	26,600	40.7
1986	34,600	30.1
1987	47,200	36.4
1988	63,000	33.5
1989	83.000	31.7

In electromechanical components, Siemens new orders amount to DM 791 million, sales DM 800 million and capital spending DM 69 million.

Computers: Siemens has not made enough of an impact in the field of computers in the Indian market, which is not to say that there has not been a sizeable transfer of computer techology.[28] Siemens' growth in computers was significantly higher than the industry average. Increases were registered both in the German and international markets, with business activity focusing primarily on Western Europe.[29] It received new orders amounting to DM 7.5 billion, sales of DM 7.7 billion and a capital spending of DM 1.592 million. The figures include part of the activities transferred from the former peripherals and terminals group.[30]

A major share of this favourable business was attributable to Rs. 52,000 worth of driven, general purpose computers manufactured in Siemens systems plant in Augsburg. The 7.500 HGO and H 90 mainframes were among the star performers. Belgian

28. Ibid.

29 Siemens Annual Report, 1990, p.19.

30. Ibid.

Telephones was one of the customers. For future installations in the new German State and Eastern Europe, Siemens licensed Computer Electronik Dresden Gmb H (CED), formerly Robotron, to manufacture the H 60 mainframe series, Sinix multiuser computers, and PCs. Sales doubled compared to 1988 and 1,500 PCs were ordered for the worldwide airline reservation network ''Amadeus'', as the first stage of an extensive contract.[31]

However, none of this came as part of the transfer of technology package via Siemens India: First, because India was deemed not to be able to absorb this high technology and secondly, because governmental policies were restrictive on imports.[32] In a dramatic move, the activities of Data and Information Systems were transferred to Siemens Nixdorf Informations Systems AG on 1, October 1990 with a spectrum ranging from notebook PCs to advanced mainframes, from organizational solutions for offices and plants to networks for large companies with global operations. Siemens Nixdorf Informations Systems AG is the largest European computer manufacturer.[33] This will definitely benefit Siemens' productivity, but all in all, it has not made a substantial contribution to the Indian industry.

Telecommunications: This has been far more successful as an area of technology transfer from FRG to India in the Siemens' framework. In fact, Siemens' entry into India began in this sector. In 1867, Werner von Siemens personally supervised the laying of the first Indo-European telegraph line, covering a distance of 11,000 kms. It made history by providing the first direct telegraphic link between London

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31. Ibid.

32. Ibid., n.20.

33 Computer Today, (New Delhi) vol. 6, no.60, Feb. 1990, p.12.

and Calcutta.[34] Siemens is today the acknowledged world leader in telecommunications technology. It offers the three C's of technology: communications, computers and components. These are the key technologies shaping the future of telecommunications.[35]

The importance of telecommunications in Siemens can be seen from the fact that out of a total turnover of DM 52 billion in 1985, communication equipment accounted for DM 20 billion.[36] Combining international experience with in-depth knowledge of local conditions enables Siemens to help manage a country's specific communication problems. It plays a key role in planning, maintaining and implementing tailor-made projects that fit in with the country's infrastructure, geography and climate. Siemens has a built-in infrastructural scope for growth.[37]

The Siemens range of products and systems in telecommunications covers amongs other items, digital public telephone exchanges; telex and data exchanges, packet switching systems, electronic PABXs for office automation, mobile communication systems, optical communications, transmission systems, satellite earth stations and radio relay systems, electronic telephone instruments, teleprinters (telex terminals), and measuring instruments for telecommunications.[38] Siemens telecommunications technology has been absorbed into the telecommunications network in India as indicated by the Indian Telephones Industries Limited,[39] but again, not as much as

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34 Siemens In India (Bombay) 900/040, Cover Page, 1989.

35 Communications Tecnology for Today and Tomorrow, (Bombay) Tata Press 8865, 1989, Cover page.

36. Ibid.

37. Ibid.

38. Ibid.

39. Interviewing Chairman ITI, U.D.N. Rao, 28 June, 1991.

could have been. There is Telex tie-up with Siemens and the dialogue is on to upgrade the former under production. However, there is competition for digital switching equipment from Alcatel, France. While the analog is being phased out, for optic fibre equipment there is collaboration with NKT, Denmark. The need for the transfer of VLSI chips technology has arisen, and this is being negotiated with ARCUS Technology Inc. USA.[40] The Siemens system EWSD is the world's most modern digital switching system. Since 1980, 24 countries have used it including Germany, USA, China, Chile, Austria, Brazil, Taiwan, Switzerland, and others. In short, its major advantage is that it is cost effective, the latest in semiconductor technology, has low power consumption, can inter-operate with all standard signalling systems and is extremely reliable, with a breakdown of not more than 0.24 hours in a year.[41] Another efficient system is the EDX-C which has been inducted by the Department of Telecommunications for their model switching centres at Bombay, Calcutta, Madras and New Delhi and with similar exchanges installed at Ahmedabad, Bangalore, Ernakulam, Hyderabad,Gauhati, and Jaipur.[42] ECIL is collaborating with Siemens in the indigenous manufacture of EDX-C. There are many advantages, some of which are important subscriber services—abbreviated dialling, direct call, notification of chargeable time, multi-addressing conference call, user classes, etc.[43]

The EDX-P/ANP is a packet switching system, basically sharing the tasks among various network modules. Siemens has supplied nearly 350 packet switching systems with more than 30,000 parts throughout the world. Of these, 157 systems are

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40. Interviewing Deputy Director, ITI, Mr. Narayanan, 28 June, 1991.(Annual Report, ITI 1987-88), p.23.

41 Communication Technology for Today and Tommorow, (Siemens: Bombay, 1989) p.2

42 Ibid. p.3

43 Ibid.

in use in the USA. One of the major advantages of this is that this technology can be conveniently and economically integrated into ISDN (Integrated Services Digital Network), thus offering a future–oriented solution for all communication needs.[44] Again, the advantages of the above are cost effectiveness, a higher level of transmission quality, and a space saving and energy saving design. The modular system in both software and hardware provides for flexibility for connecting new subscribers and services and combining previously separate networks.[45] Apart from this,Siemens has made an impact via the PABX systems, mobile communication system, transmission system (both analog and digital); it has also made tremendous headway in optical communication, in the master set and teleprinter, while going ahead with measuring instruments for communications. [46]

Right now, Siemens is actively participating in the telex expansion programme in India. Siemens System EDX is operating in Bombay, Madras, Calcutta, New Delhi, Bangalore and Hyderabad, with DOT/MTNL/Videsh Samachar Nigam. Soon exchanges at Ernakulam, Jaipur, Ahmedabad and Guwahati are to be commissioned.[47] Siemens telephones are being manufactured by licenses in the State Electronic Corporations and private sectors. Telex exchanges, as stated earlier, will be manufactured by ECIL, while Siemens electronic teleprinters will be manufactured by WEBEL Telematik Ltd. [48] R and D, being a positive indicator of progress, has played a major role in Siemens. The company has taken into consideration dwindling reserves of

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44. Ibid. p.4.
45 Ibid
46 Siemens in India.900/040. p.1
47 Ibid.
48 Ibid.

energy, raw materials and the growing threat to the ecological system. Over 30,000 people are involved in the company's R & D activities, on which more than 8.3 percent of company sales was spent annually,[49] and now more than 12 percent of the turnover is invested in R & D to stay on top of their individual specialisation and complete with international high-technology firms.[50]

Micro-electronics plays a key role in R & D along with information and telecommunications technologies and Siemens has been trying to achieve a breakthrough in this field. The Semiconductor business was marked by a dramatic fall in memory prices and fierce competition, precipitated by excess capacity on the world market and the declining exchange rates of the dollar and the yen. Adjusted for the divestment of selected operations, new orders and sales came close to the prior year's figures (1989) due to a further increase in production volume.[51] Despite this higher output, sharp price cuts resulted in slightly increased losses.[52] Major emphasis is on the fact that the success of Siemens technologies in international competition is backed by sizable capital outlays for telecommunication systems and the tailoring of terminal equipment to widely varying market requirement.[53]

In Defence Electronics: the changes in new orders and sales were primarily attributable to the Patriot air defence missile system, which generated orders in 1988-89, leading to higher sales. Siemens is the general contractor in charge of adapting Patriot for German defence requirements.[54] Siemens' acquisition of British Plessey

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49. Ibid., n.41.......p.13.
50. Telematics India, Dec. 1989, p.64.
51. Siemens Annual Report, 1990, p.24.
52. Ibid.
53. Ibid., n.20.
54. Op. cit., p.21.

Defence systems Ltd. and Plessey Radar Ltd. ensures that its production facilities in two of Europe's key regional markets, Great Britain and Germany, would meet its needs for communication, reconnaissance, and command and control systems.[55]

In India, Siemens has had only a marginal profile in defence electronics. It has provided electronics at the level of computers in defence establishments and telecommunication systems. It has had a greater impact on power engineering, automation, and medical engineering. Yet, experience of human management inputs and technology transfer packages in India show that though much has been transferred, there is scope for more transfers in the future. Siemens is pursuing most of the fifth generation technologies. The company is a founder of the ECRC and is quite active in ESPRIT. It places special emphasis on large architecture systems, personal computers and VLSI.[56] In the context of the assessment of product analysis in technology transfer it is necessary to assert that Siemens' role is important, since it is also working on fibre optics, workstation processors, and integrated digital networks.

Servicing over 1.5 million customers, Siemens is one of the most powerful information technology companies in Europe. Sadly, its computing equipment does not seem to command the market share that the Japanese or American manufacturers enjoy.[57] Its recent takeover of Nixdorf does make it a formidable competitor to the American and Japanese manufacturers. Siemens does provide most of the scientific leadership in West Germany in the technology war.[58] In the framework of international relations and international political economy, three larger issues emerge

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55. Ibid.

56. Harrison, Brandin, The Technology War, (New York: John Wiley 1987), p.188

57. Ibid, p.189

58. Ibid.

in channeling Siemens Corporate Philosophy and scientific local management: 1) the unification of Germany; 2) the breakdown of the old antagonistic systems of the US-USSR rivalry; and 3) the unification of the European common market.

A study of Siemens in the context of the above trends sevrals that in the first, it is more than consolidating its position in Western Europe, Britain and the USA. With Germany's unification, the domestic electrical and electronics market has expanded by DM 14 billion, an increase of eight per cent.[59] A particularly dynamic development—a five-fold growth by the year 2000—is expected over the medium term in the East German market. This will be generated by the strong demand arising from the development of the infrastructure: power supply, telecommunications, transportation systems, medical engineering and plant modernization (environmental engineering,automation, industrial and building systems electricals installation equipment, information technology). Siemens goal is to have an impact on all of these areas. To this end, an investment of one billion DM has been invested and 25,000 to 30,000 people are involved in research and development, production, distribution, installation and service.[60] Siemens has negotiated joint agreements in the areas mentioned above and orders in the former GDR in 1989-90 climbed to approximately DM 350 million, thus close to achieving medium-term goals just one year after Germany's unification.[61]

Secondly, the breakdown of the antagonistic rival US-USSR system has, of course, opened markets in Central and Eastern Europe. Siemens has established

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59 Siemens Annual Report, 1990, p.7.

60 Ibid.

61 Ibid.

its own companies in Eastern Europe. So far, it had been concentrating on industrial and building systems, automation and medical engineering, but it is expecting sizeable orders for telecommunication equipment and environmental protection technologies. Several joint ventures have already been formed in the field of public communication networks. [62]

Thirdly, the European common market phenomena has induced Siemens to expand its market position in Western Europe and Britain itself. In Western Europe (but excluding Germany), new orders increased 16 percent to about DM 21 billion and sales rose six per cent to approximately DM 18 billion in 1989.[63] In Great Britain, Siemens has concentrated on business sectors. Reparted for its innovative technology and solid growth, it has become Britain's leading supplier of medical engineering systems and a major producer of factory automation equipment.[64] In France, Siemens' position has strengthened in key areas, such as medical engineering systems and industrial automation. The expansion of the facility at Toulouse already has enabled an increase in sales of 14 per cent to DM 328 million. By acquiring the French company INZ S.A. Plaisir (Paris) and transferring the local data systems operation to it, a major step toward intensifying data processing activities in France has taken place.[65] Primarily the public telephone system and transmission equipment business, have generated expansion in Italy, mainly because of heavy capital investment in digital technology by Italian Telecommunications. Also orders have been booked for radiology, switchgear and control equipment and 7.800 and

62 Ibid. p.30.
63 Ibid. p.29.
64 Ibid.
65 Ibid.

7.500 computers.[66] In Portugal, too, large scale orders were booked in 1990 for 30 locomotives, 42 rapid transit trains and 1.25 million telephones lines using digital switching technology worth DM 500 million.[67] Hence, the idea of the European Common Market has definite positive effect on Siemens, already consolidating its activities in Western Europe.

However, for Siemens, the top priority market has always been the US since it is the world's largest electronics market. Siemens' new orders rose to $ 4.4 billion and sales rose 16 per cent to $ 4.1. billion. During the past decade,Siemens' US operations have grown at an annual rate of about 23 percent with 29,000 employees in eight large companies.[68] One interesting phenomenon is that nearly 15 per cent of Siemens' US sales are exports. A collaborative company with British GPT Holdings Ltd. has been formed at Florida and named Siemens Stromberg Carlson as a result of a heightened awareness of energy and energy systems, Siemens has founded a new US company, Siemens Transportation Systems, Inc.[69] Siemens ranks amongst 150 of the top US companies but is not without competition, as is evident from the battle between Siemens and AT & T of the US for the mantle of world leader in the telecommunications industry.[70]

Siemens also wants to expand into Latin America, South and South East Asia, but India will definitely have to open up space for Siemens, if India wants its share of the technology that Siemens has to offer. The new industrial policy might help it

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66 Ibid. p.30.

67 Ibid.

68 Ibid.

69. Ibid. p.31.

70. Financial Times. (London) 18 January 1989

to do just that. India will have to make itself high-technology 'acceptable'. It is imperative to note' in this context, the emphasis on the international division of labour; collaborations,and acquisitions. In order to exploit the opportunities thus offered, Indian industries and policy-making bodies need to train the best available factor: human resources. In a sense, Siemens has managed to do this in India with its outward looking employees' benefits programmes, absorption of trainees and the like. India is definitely in a position to absorb more high technology. More needs to be transferred through joint ventures or subsidiaries of foreign companies.

The March 1991 Board Report stated Siemens' exports during the year were Rs. 54.2 crore and it earned a net foreign exchange of Rs. 30 crores. The company also bagged a big export order, valued at Rs. 28 crore.[71] Moreover, Siemens has promoted a new company, the Siemens Information Systems, with 51 percent equity participation for software development and marketing.[72] This of course, is an even more encouraging step in the transfer of computer and information technologies from the FRG to India. The major activity in the Indian market for software is on site professional services which will establish the credentials of Indian software professionals worldwide. Yet, its record is abysmal as far as tapping the German market is concerned. Germans have indicated little desire to do business with Indians in this area.[73]

Heinrich Pierer, the new Chief Executive of Siemens paid a visit to India in February 1992 along with other senior officials from Siemens. Pierer was very ju-

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71. Indian Express. (New Delhi) 2. July 1991

72. Ibid.

73. The Economic Times. (New Delhi). 6 May 1992.

dicious in his choice of words about the company's plans for India. He said,

> "During this period of transition (in India's economy), we in Siemens will not adopt a watch and wait attitude. We shall not wait to see India succeed and only then help her. We shall help India succeed as best we can. It is at this time that India needs catalytic investment—investments that will trigger, in a multiplier manner, more investments. Therefore, Siemens wishes to play this catalytic role."[74]

Few companies could be in a better position to do this. Of Siemens' profits in 1991, amounting to $1.1 billion, almost half came from earnings on financial investments worth $11.3 billion.[75] Siemens AG, with a turnover of $45.6 billion (1991) is the third largest electrical and electronics company in the world after General Electric and I BM. Almost $7.6 billion of its revenue comes from computers; $7.1 billion from telecommunications in the public domain, where it ranks third in the world after AT&T and Alcatel; another $3.1 billion comes from its office phone business where it is number one in the world; it ranks third in the power generation market; it is neck to neck with GE for number one position in medical engineering; other businesses include industrial and building systems, transportation systems, defence electronics, appliances, audio and video systems and semi conductors.[76] Considering all this, it is but natural to think that Siemens as a firm can be a tremendous channel of technology transfer from Germany to India, in both telecommunications and computers, apart from other areas.

It needs to be mentioned here that Siemens in India has concentrated more on the power sector, and has had tie-ups with Bharat Heavy Electronics Limited (BHEL) and National Thermal Power Corporation (NTPC) amongst others. Now, however,

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74. International Business Week, (New York), 9 March 1992, p.18
75. Business India, (Bombay) March 30-April 20, 1992, p.50
76. Ibid.

Siemens is going more and more into telecommunications and computers. In fact, Siemens has tied up with India's Informations Technology Limited (IITL) and made the bed for providing cellular mobile telenetwork in four major cities Delhi, Bombay, Calcutta, Madras.[77] Thirteen out of 18 groups special mobile (GSM) system installations all over the world have been set up by Siemens. The Indian Departments of Telecom has also decided to adopt this system with Detecon as partner in Germany (on behalf of IITL). Hence, the scenario for high technology transfers from Siemens AG in Germany to Siemens India in telecommunications and computers seems bright and should be encouraged.

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77. The Economic Times, (New Delhi), 5 May 1992.

CHAPTER VII

WIPRO

WIPRO INFORMATION TECHNOLOGY LIMITED

(Firm Analysis II)

Wipro Corporation is a diversified integrated corporation engaged in consumer products, engineering, and professional electronics. Wipro Information Technology Ltd. is a subsidiary of Wipro Ltd. It develops, manufactures and markets a range of computer systems and solutions. Wipro Systems Ltd., also a subsidiary of Wipro Ltd., develops and markets software for export and domestic markets. Its other companies in professional electronics are: Wipro Beckman Ltd. (a financial joint venture with Beckman Instruments International Inc.), manufacturing and marketing analytical and clinical instruments; and Wipro GE Medical Systems Ltd. (a financial joint venture with General Engineering) manufactures and markets medical systems.

Wipro Corporation sales of the year ending 31 March 1990 were Rs. 3,033 million. Over the last ten years, its sales have grown at an average annual rate of 22 per cent and shareholders, equity at 28 per cent entirely through earnings.[1] Wipro Corporation ranks among the top 100 publicly held corporations in India.

1. Interview with Anal Jain, Vice President, Marketing, Wipro, Bangalore, 19 June 1991.

Table I

Consolidated Financial Highlights[2]

	Rs (Millions)		
	1989-90	1988-89	1979-80
Sales and other income	3033	2485	432
Profit after tax	87	60	7
Shareholders, funds	346	283	30
Return on average share holders, fund (%)	28	23	24
annualised U.S. $1 = Rs 17			

Wipro's corporate philosophy, which it has tried to project consistently, is first, respect for the individual and maintaining that people are their greatest asset. Secondly, Wipro Corporation has aimed to achieve and maintain a position of leadership in every one of its business enterprises. Third, the corporate aim is to pursue every task efficiently and accomplish it on schedule. Fourth, it believes in governing individual and company relationships in the highest standards of conduct and integrity. Fifth, it is the aim of Wipro Corporation to be close to the customer in action, example and spirit and ensure superior quality products and services. Sixth, understandably, Wipro measures its effectiveness by the long-term projects it completes for its enterprises.[3]

It is true that its key strength is aggressive and innovative marketing aiming towards its customers. In fact, Wipro has built an impressive track record in low

2. Wipro Corporation, Corporate Overview, (Bangalore, July 1990) p1
3. Ibid.

cost manufacturing and won the Government of India Highest Productivity Award for 1988 in the Electronics Industry.[4] It also won the Award for Excellence in the area of Computer systems in 1990.[5]

Motive: Wipro Information Technology Limited (WITL), a subsidiary of Wipro, like other multinational companies, has a strong profit motive. Along with this, it is prepared to indigenize and establish its depth of technology absorption. WITL is one of India's best computer firms. It ranks third in sales and fifth in exports.[6] It caters to the Indian market to a sizable extent. Its growth rate has reached 72.88 percent during 1987-89.[7] It has proved itself to be a medium level company of truly international standards.

It was at the CSI 1981 Exhibition that WIPRO Information Technology Ltd. (WITL) made its debut in the Indian computer industry with the 3086 based series-86 mini. Eight years later, it proved to be the third largest information technology company in India (1988-89 revenues amounting to Rs. 93.95 crores) with a comprehensive product range backed by a strong R & D orientation, and a sound image for reliability and customer support services. In an industry that still carries the stigma of screwdriver technology, WITL has proved that a company in the Indian information technology business can design and manufacture products while maintaining steady growth.[8]

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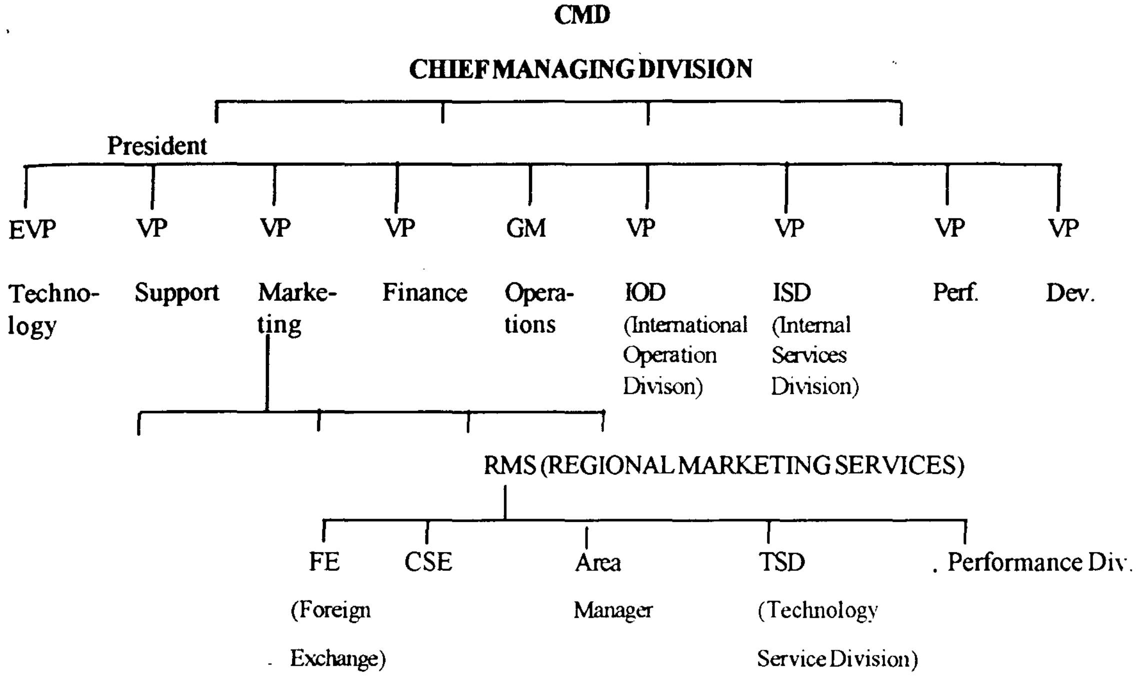
4. Ibid, p 2-2
5. Letter from N Vittal, Secretary, Department of Electronics, Government of India, New Delhi D.O. No. 4(6)/90-P&C dated, 15 April 1991
6. Computer & Communication Information Technology, (Bombay) July 1989 p.2
7. Ibid , p. 26
8. C & C's Information Technology, July 1989, P.28

Corporate Structure:

Fig.I [9]



Decision-Making: This really means the selection of courses of action from among alternatives. Given an awareness of an opportunity and a goal, the core of planning is really the decision-making process.[10] Thus, in this context, decision making might be thought of as 1) premising, 2) identifying alternatives, 3) the evaluation of alternatives in terms of goals sought, and 4) choosing an alternative, that is, making a decision. This really places decision making as one of the steps in planning.[11] Further, effective decision making should be rational. 'Satisficing' is picking a course of action that is satisfactory or good enough in the prevailing circumstances.[12] One

9. Interview with Anal Jain, Ibid., n.1.

10. Koontz H et al, Essentials of Management, Mcgraw-Hill, (New York: 1986) p.136

11. ER Archer, ''How to make a Business Decision: An Analysis of Theory and Practice,'' Management Review, vol. 69, no.2, February 1980, pp 30-34.

12. HA Simson, Administrative Behavior (New York: Free Press, 1947) p 72.

of the major components of such decisions making is its cost effectiveness.

The factors that determine how much time and attention should go into making a decision are the size of the commitment involved, the flexibility or inflexibility of the plans to be put into effect, the certainty or uncertainty of goals and premises and the impact of the decision on people. Finally, decisions must be made with the recognition that organizations are open systems.[13] With the above in mind, Wipro has both a horizontal administrative decision-making process and a vertical one, with nine vice-presidents in charge of their respective specialized divisions reporting to the President who is accountable to the Managing Director. The vice-presidents oversee their particular divisions interacting with the regional manager, who in turn has each of the specialized divisions under an area manager.[14]

Technology Transfer: In Wipro, technology transfer takes place in two major ways:

1) Training of skilled personnel to instill computer know-how by sending them abroad to other companies; and 2) by way of various collaboration agreements. WITL has a definite edge in having comparatively few but strong collaborators like Sun Microsystems, etc.[15]

There has been a pact between IBM and WITL for Sun workstations. IBM announced a new tie-up with WITL for marketing its Spare Station 1, manufactured by WITL in technical collaboration with Sun microsystems of USA.[16] The new alliance with Sun Microsystems will give Wipro a chance to penetrate much deeper

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13. n. 10, p 152-3
14. n.1.
15. n. 1.
16. Computers Today, vol 7, no 71, Jan 1991, p. 10

into the workstation market. "But whether IBM wins or Wipro wins, Wipro always wins."[17] That, perhaps, sums up the arrangement the two companies have worked out for themselves. With this Spare Station, there is a range of functionality that is unmatched by any other desktop workstation.[18]

WITL has also signed an agreement with a US based software company, Synercom Technology Inc., Texas, for distributing in India, a novel software package called the Informap. This is based on the spatial system technologies as the CAD systems, automated mapping and facilities management and the Geographical Information Systems (GIS)/Land Information System (LIS).[19] The package is basically meant to provide graphic solutions through the use of Geographical areas and maps. The data capture involves a number of techniques, viz., scanning, vector processing where a geographical map/ area input is fed and stored in a relational data base using the Oracle RDBMS package. A user can then add attributes to this format. Informap, which runs in the unix environment, is claimed to be supported by all the open system workstations and file servers.[20] The software package is targeted at a whole gamut of operations covering defence, telecommunications and such services as electricity, gas, water utilities, and also cartography.[21]

Another impact of the Sun Mircrosystems-Wipro tie-up has been the WITL-Tandem Inc., USA, tie- up and within a year (1990) WITL announced the launching of a software development programme. As part of Tandem's 'global alliance'

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17. Ibid.
18. Wipro product profile.
19. Computer Today, vol.7, no. 71, Jan 1991, p.13.
20. Ibid.
21. Ibid.

programme, Wipro has begun searching for software houses in India to develop application software, tools and utilities for Tandem. Tandem itself has more than 300 such alliance partners worldwide.[22] Unlike Tata Consultancy Services (TCS), which has been involved in developing software for Tandem since 1982, the companies that Wipro will enlist for support will develop software and application development tools for only the Indian users of Tandem. So far, TCS has developed and exported back to Tandem, software worth over three million dollars.[23] This coincides with Wipro's launching of two new additional systems to Tandem's product range at the international level– the non-stop cyclone, which is an on-line mainframe system said to provide a IBM 3090 performance at roughly half the cost, and the Integrity S2. The latter is a fault- tolerant high performance Unix system based on RISC technology, with a price tag starting from US $ 172,000. The Integrity machine will also be available on rupee payment through Wipro in India.[24]

In yet another development, Wipro has entered into an agreement with Fonesco Ltd. of UK for the sale of its foundry simulation software in the Indian market. Wipro has been appointed the exclusive distributor of the UK firm's solstar simulation software packages, said to be the most advanced foundry simulation CAD software available anywhere in the world.[25] The package is priced between Rs. 10 lakh and Rs. 15 lakh. Solstar will run on a 386-based machine with 2M-byte RAM and 40M-byte disk storage capacity.[26] These collaborations have been highly successful, marking

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22. Computers Today, vol.6, no. 61, March 1990, p.4.
23. Ibid.
24. Ibid.
25. Computer Today, vol.6, no.70, Dec. 1990, p.10
26. Ibid.

Wipro out to be a company successfully absorbing and acquiring technology.

Research and Development

Before the product analysis is gone into, it is prudent to see Wipro's R & D stature.

Wipro has a team of over 100 specialists in the R & D team. This is a core activity at Wipro. The company currently spends over Rs. 3.5 crores or 6.08 per cent of its total turnover on R & D. So far, it has spent a cumulative total of Rs. 14 crores on R & D.[27] It is WITL's keystone to success. Product design and innovation have helped Wipro launch new products. Its in-house R & D capabilities came to the fore in 1987, when it introduced the series-386 mini, the first production of the 80386 processor on a minicomputing platform in the world, and in 1989, when it launched the Landmark II, the first 80386 based multiprocessor implementation of the Multibus II architecture.[28]

It is a measure of WITL's R & D technical competence that it implemented systems engineering orders such as supporting the launch of IRS-IA, India remote sensing satellite, and designed the parallel processing platform for the first parallel computer in India developed at NAL.[29] It is also Wipro's R & D that won it in 1989 the National Award for R & D instituted by DSIR. According to Dr Sridhar Mitta, Vice-President, Technology WIPRO, "The awards have been a real morale booster for us at Wipro. It is a recognition of our commitment to indigenous development."[30]

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27. Computers Today. vol.6. Feb. 1990, p.5.
28. Computers & Communication. July 1989. p.2
29. Ibid.
30. Computers Today. vol.6. Feb. 1990, p.5

Further, in-house R & D brought out a minicomputer with the capability of the Cray I supercomputer at the Computer Science Industrial (CSI) fair in1990. Designed in-house by Wipro's R & D team, the 860 MS is built around the 1860 Intel RISC chip which gives the system a number crunching capacity of 40 MIPs. It runs on Unix system V.4.0 and has an optimizer Fortran compiler. The minimum configuration with a 16M-byte RAM and 170M-byte hard disk drive is priced at Rs. 10 lakh.[31] The Landmark 860 MS is aimed at scientific research institutions and Wipro hopes to export Rs. 20 crore worth of systems by end of 1992. The typical applications of Landmark 86 MS would include computational fluid dynamics, finite element methods, image processing, molecular modelling, material science, etc., according to Anal Jain, Vice-president Marketing, Wipro Infotech.[32] From the Wipro stable, come two more additions based on in-house R & D—the WEISA workstation and the S-6840V minicomputer. The latter built around the Motorola 68040 microprocessor, runs at 25MHZ and has Wipro's front of Unix system V 3.2. Marking Wipro's entry into the EISA marketplace, is the WEISA machine supported by a 386 Sx 32-bit CPU and Unix system V.4 with graphical interface. The system has 32M-bytes on board.[33]

Products Analysis: Apart from the products which fall within the collaboration projects and those which come within the ambit of the R & D, there are a few products covered by WITL. Even so, the product profile of WITL can be brought within six heads: PCs, Minis; Workstations; Printers; Systems Engineering; and Mainframes.[34]

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31. Ibid, no.70, Dec. 1990, p.4
32. Ibid.
33. Ibid.
34. Interview with Anal Jain, Ibid., n.1.

PCs: It is far ahead in PCs as the leader in micro computers with its range of PCs, XTs, ATs, 386 SX, Genius 386 and Genius 486. Its major advantage is the Unix v.4 operating system.[35]

Minis: The range includes the proven landmark and S-6833 systems. The others have been mentioned in the section on R & D.

Workstations: These have also been mentioned earlier as part of Sun's Motorola family and the powerful SPARC. Wipro workstations provide platforms incorporating high computation and graphics as well as flexible networking, resulting in high productivity. Transparent networking also leads to true distributed (clientserver model) architecture implementation. Based on open standards, it also spells functionality, productivity, and flexibility.[36]

Printers: A powerful partnership, not mentioned before, is the collaboration of Wipro with Seiko-Epson Corporation of Japan. This has meant the production of printers, such as LX-800, FX-105 S printer, EX-1000 and the latest 24 pin LQ-1050.[37]

Systems Engineering

1. Caters to customized solutions involving computers, communications and controls.

2. Systems are built around Wipro and internationally secured subsystems.

3. Projects are executed for defence, space, avionics, airlines and telecom-

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35. Wipro Infotech Product Profile, Bangalore, 1989
36. Ibid.
37. Ibid

munications.

4. Major areas of working include Ruggedisation, Real Time system, parallel processing, simulation, data communication telemetry, Fault tolerant systems, Radar signal processing.[38] (See Annexures I-denoting multi-layer security system network covering both military and civilian technologies).[39]

From this, it is very evident that Wipro is a major actor in supplying computer hardware and software in the defence sectors. This was substantiated by A Paulraj, Director, R & D at BEL, who said Wipro was indicative of how easily Indian science and technology could absorb, adapt and assimilate high technology, and then indigenize and use it. He also went on to say how Wipro had supplied customized defence requirements.[40] To stretch the point further, though precise figures are confidential about Wipro's input into defence ,WITL is in Indian Space Rsearch Organization (ISRO), Satellite and Tracking Command, Vikram Sarabhai Space Centre, Laborartory Research and Development in Electronics (LRDE), Defence Research Development Organization (DRDO) (Hyderabad), Bharat Dynamics Ltd., Bharat Electronics Limited (BEL, Bangalore), Bharat Heavy Electronics Limited (BHEL, Hyderabad), Hindustran Aeronautics Limited (HAL, Bangalore), Aeronautics Development Agency (ADA, Bangalore), National Oceanographic Laboratory (Cochin).[41] A sizeable input is in the Navy.[42] Here is a clear case of dual use technol-

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38. Wipro Systems Engineering Division Documents. 1990.
39. Ibid.
40. Interview with A Paulraj. Director. Centre for Development of Advanced Computing and Director. Central Research Laboratory. BEL. Bangalore. 26 June 1991.
41. Interview with Anal Jain. Ibid., 1.
42. Wipro Systems Engineering Div. Documents. Bangalore 1990

ogy transfer at two levels: a) via collaborative agreements; b) internally through WITL to the Indian Navy.

Mainframes: Tandem, along with Wipro, brought mainframes to India with the advantages of availability, on-line linear expendability, single view image of distributed databases, as well as better prices and performance. With a host of standard database tools (like ORACLE & INGRES) with Tandem systems, cooperative processing with front-end workstations or minis is now easy.[43]

Convex: This is another product with a range of high performance vector and parallel processing systems. It provides affordable supercomputing for a broad range of scientific and engineering applications, such as finite element analysis, computational fluid dynamics, visualization, seismic modelling, meteorology, molecular modelling and computational chemistry.[44] IIT Kanpur now has convex minicomputer. It was inaugurated on 6 June, 1991.[45]

Networking: This is a major and an important area integrating information technology products. Wipro offers solutions for networking through both Ethernet based LAN (Local Area Networking) and X.25 based WAN (Wide Area Networking).[46] Networking solutions from the standard Novell Netware to powerful Unix and multi OS networks are available. Both the current TCP/IP and the emerging OSI protocol standards are supported on the range of Wipro machines. Bridges to link LAN segments, modems, PADS and switches and communication software complete the

43. Wipro Product Profile. Bangalore. 1990.
44. Ibid.
45. Interview with Anal Jain. Ibid., n. 1.
46. Wipro product profile. Bangalore. 1989.

range.[47] Already, major installations for commercial data networking and critical applications like satellite tracking, defence applications and many others have been successfully implemented.[48]

Software: This is one of Wipro's strengths. The entire range of standard operating systems such as packages in Computer Systems like MSDOS, Netware, Unix V.3.2, UNIX V.4 SUN OS and 1 RMX are supported on Wipro platforms. So also are a wide variety of RDBMSs like ORACLE 6.0, INGRESS 6.2, UNIFY 2000, A CCELL, SYBASE & FOCUS. There are special packages for maintenance management, library information and foreign exchange package for banks.[49]

The product range is wide. Almost all collaborations have been successful because of Wipro's own management skills and ability to absorb technology. Naturally, there are major problems too. WITL has adopted an unduly cautious approach in in product planning and marketing. The company has not always been aggressive in finding and exploiting profitable niches in the proper business sense.[50] Its entry into the PC and workstation market was late. These slow responses to the market, although WITL has made up for them with subsequent flair and panache, could prove to be its handicap in a market showing signs of rapid change.[51] In the PC market and, to an extent, the mini market, where product differentiation is marginal, market survey would appear to be a crucial point. WITL's sales promotion and advertising has been low in terms of expenditure, and sober in content even as its

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47. Ibid.
48. Ibid.
49. Ibid.
50. C & C's Information Technology, (New Delhi, 1989) p.29.
51. Ibid.

competitors have gone in for large advertisement and sales promotion budgets and aggressive advertising content. In this area, the company's expenditure was only 0.7 per cent of its sales turnover in 1988 in comparison to 1.62 by HCL Ltd.[52]

Other factors that pose obstacles and hindrances to Wipro's growth are also, ironically, mostly government guidelines to the computer industry, viz.:

1). Industrial license; 2) Import license; 3) Import/Export Handbook; 4) Customs clearance; 5) Fiscal duties/levies; 6) Phased manufacturing programme; 7) Reserve Bank's policies on foreign exchange; and 8) Export commitments.

Where both industrial and import licenses are concerned, Sridhar Mitta, VP, TSD, Wipro, strongly recommends making a bonfire of licensing policies.[53] Deregulation and less control via licensing seem to be the general trend in the Indian computer industry. Basically, the slump in the computer industry after 1988, followed by an unnatural boom in 1989-90, has slowed down its growth. The industry was growing at a rate of 70 per cent but the trend has since been downwards.[54]

This could not have been due to saturation of the market, as the potential has not even been scratched. ''It is due to changes in the government policies. After initial encouragement to the computer industry in 1984-85, which led to a spurt in growth, the government has really given the industry second hand treatment. There have been successive increases in excise duties and even in custom duties. The squeeze on imports was the last straw that virtually broke the camel's back. This has also

52. Ibid.

53. Interview with Dr Sridhar Mitta, Vice President, Training and Services Division, Wipro 26 June 1991.

54. Computers Today, vol.7, no. 74, April 1991, p.62.

led to more and more unauthorized imports. Due to the presence of a huge potential demand, the products are being pushed out of the range of a majority of buyers by increasing duties indiscriminately. This could be the fundamental reason for the slow-down. Also, there are certain negative aspects of the industry which are responsible for the current situation. For instance, there has been insufficient focus on user-training; neither has adequate attention been given to the development of a strongsoftware industry locally : Moreover, a sufficient R & D base has been lacking all along."[55] In a nutshell, this covers all aspects of government policy towards the industry.

It has to be stated in all honesty, that the interim budget of 1990-91 spared the computer industry additional imports or other duties. In fact, apart from the changes applicable to all other industries, like the abolition of section 115 of the Income-Tax Act relating to taxing book profits, the abolition of investment allowance, and a rather ambiguous 'liberalization of import of computer systems and software for execution of software exports', the industry was left completely untouched.[56] A customs duty reduction to 60 per cent ad valorem tax on components imported for the manufacture of specified electronic testing and monitoring systems, also gave greater emphasis on quality control.[57] In fact, by maintaining the status quo, the government, in effect, gave the computer industry more time to get its act together.[58]

Ironically, the 1991-92 budget was expected to be harsh and, surprisingly, it

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55. Interview with Ashok Soota, President, WIPRO, INFOTECH; ARo see Computers Today, vol. 7, no. 74, April 1991.p.62.
56. Computers Today, vol. 6, no.62, April 1990, p. 12.
57. Ibid.
58. Ibid.

was not. Yet, it is plain that government policies mostly turn into governmental restrictions.

One major example is the import policy of the Government of India in January 1991. ''First and foremost, this is disastrous for the industry,'' emphasizes Sumit K Pal, regional manager, ORG Systems. ''It is panic reaction from the government,'' avers Rishab Kumar, Director WIPRO Infotech. Both refer to the import policy revisions.[59] The most hard-hitting measure has been the Reserve Bank of India's notification to all nationalized banks not to open Letters of Credit (LCS) for the electronic sector and also the need to have 50 per cent cash margin. Other steps taken by the government include: removal of a number of items from the import entitlement of electronics industry, etc.[60] These strong measures would have a deleterious impact on the industry, especially when there is an acute shortage of foreign exchange. The computer industry particularly seems to have been hit below the belt. Coming at a time when 50-60 per cent business for most of the companies is transacted only during the last quarter of the year, these steps will have far reaching and adverse effects, more so for local manufacturers who depend on imported components. If a valid license is given, it is like a promissory note from the government. Banks refusing to open L/CS, amounts to a denial of a promise of the government.[61]

Foreign exchange is not really stopped from being used by this kind of import policy since larger companies can still get their goods through other means, such as cash on delivery basis and site draft. On the other hand, companies become skeptical

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59. Computers Today, vol. 7 no. 71, January 1991, p.10.
60. Ibid.
61. Ibid.

of government policies and begin planning only on a short-term basis. One way out of this is for the industry to tap unutilized World Bank credit. Of course, it may mean more procedures and delays, but ICICI and IDBI could finance schemes and utilize bilateral credit.[62] Alternatively, imports should be phased out.[63] The July 1991 budget simplified matters a great deal for the computer industry. The abolition of industrial licenses indicates that a computer can be set up any time, anywhere.[64]

With the new industrial policy, it is likely that new entrants like IBM, which had earlier wanted to tie up with Tatas, may now want to come on their own with a 51 per cent stake. The MNCs which are already in India with a stake of 40 per cent may well want to increase their share to 51 per cent. The software industry is particularly excited about the decision to allow 51 per cent foreign equity holding for trading companies primarily engaged in export activities. Some foreign liaison offices will now be in a position to act as trading houses. The software industry, which has constantly suffered due to lack of international marketing, can now utilize the services of these liaison offices turned trading houses to market their wares internationally.[65]

Import of software has always been dependent on the export potential. This is more so now with the government policy and, therefore, computer units want the government to extend the liberalization policy to the information technology area to achieve an export target of Rs. 1000 crore in two years.[66] Of course, the 100

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62. Ibid.
63. Ibid.
64. Times of India, 25 July 1991
65. Ibid.
66. The Times of India, 30 July 1991.

percent tax exemption for software exports would also enhance the export growth potential.[67] The computer industry has a high export growth potential and could become one of the 'Asian Giants' such as Taiwan, Singapore, South Korea etc. The hindrance has been as stated earlier that government guidelines have turned into governmental restrictions and prevented India from having an equally high export growth. Dr Sridhar Mitta of WITL was emphatic about this, while clearly identifying the constraints of the Indian situation, as reflected in the Indian market, which has varying expectations and is a price-sensitive market. Secondly, government constraints by way of regulatory procedures have inhibited the growth of the computer industry. Thirdly, fiscal constraints frame also hindered growth. Fourthly, infrastructure has been an inhibiting factor, e.g., there is better infrastructure in Taiwan and Korea. Fifthly, US regulatory procedures too have been inhibitive.[68] This was a specific reference to the issue of intellectual property rights (dealt with in the section on Telecommunications).

Transfer of computer high technology, according to Sridhar Mitta, should mean value addition to the Indian industry and not merely indigenization in the Indian context. It is beyond doubt that Indian industry and culture is well able to absorb technology. Projection of technology would mean base technology multiplied by effort to minimize application. This is usually not done because of the constraints of the situation. Joint ventures would mean more flow of technology. It would be sequential.[69] Now, it is almost clear that the number of collaborations would be reduced while foreign

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67. Ibid.
68. Interview with Dr Sridhar Mitta, V.P. Wipro, 25 June 1991.
69. Ibid.

investment would increase. By changing the earlier restrictive policies there would be less import in real terms, more net inflow of foreign exchange and more exports.

It is to Wipro's credit that even during the slump year of 1989-1990, the company did not fire personnel but hired them. It also was able to keep up its production, maintain its positive profile in the market and the industry as substantiated by Graph 1, [70] in which is shown that users displayed a high degree of awareness of WIPRO and HCL but were less aware of ESPL and OMC by way of vendor rating. In terms of user rating, Tata Unisys figured prominently, followed by Wipro and HCL, (Graph II).[71] If awards also represent credibility and success, then award the Department of Electronics to Wipro for 1990, is a further substantiation of Wipro's success.[72]

Wipro is geared for fast track, fast changing technologies. Along with this, it does follow evolving standards. It is part of the industry group which is contributing great-deal in technology advances. It does have a lot of unutilized potential, even though it is able to successfully purchase technology and assimilate it. The Indian environment does present a closed market, low volumes, high cost and low affordability. Also, there is reluctance to pay for software. Further, the component industry is virtually non-existent in a severely competitive international market. For India to become one of the Asian Tigers in this field, such firms as WITL have to achieve much higher productivity and sales.

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70. International Data Corporation (India).

71. Ibid, p.21

72. D.O.No. 4 (6)/90-P & C dated 15 April 1991. Letter from N Vittal, Secretary DOE to Ashok Soota, President Wipro Infotech.

Chapter VIII

Conclusions

The collapse of the Soviet Union, the unification of Germany, the Gulf War and the economic unification of Europe have perceptibly altered the traditional equations of security perceptions of her major world powers. They have, in turn, influenced India's foreign policy and options with regard to security requirements in the context of the fast emerging global socio-economic order and the changing international correlation of forces. In this context, the major issue of primary concern has been and continues to be the attitude of the Western developed nations to exports of high technology for use commercially as well as for India's defence and space programmes. The liberalisation policy of the Indian Government has created a somewhat favourable environment for foreign transfer of high technology. The effective of these profound changes seem to be beginning to be felt. Transnational giants of industry, such as IBM, Digital, Motorola, Olivette, Hewlett-Packard, etc., have already entered into tie-ups and have commenced or upgraded their operations in India. The private sector is increasingly switching over to investments in high technology industry, particularly in electronics. Electronics is one of the most globalized of major industries and its international division of labour is of interest both in itself and as an antidote to the parochialism which often accompanies the debate on high-tech in certain regions and localities. This international division of labour projects itself clearly in the computer and telecommunications sector as seen in this study. The concept of globalisation in these two sectors is conclusive.

India has institutionalized its policy-making with regard to the acquisition of high technology through transfer of technology. Its policy perceptions in this regard are reactive instead of being proactive. Structure in an interacting mode have been set up built implementation of policy has not yet been up to the mark. There are hardly any major bodies directing, evaluating and assimilating high-technology acquired through transfers. Moreover, the government sector unfortunately, has not yet attempted to take the fullest advantage of its liberalization measures for operating on the global market. On the contrary, it is allowing itself to be reduced to subordinate status in the Indian market. It is thus quite clear that Indians are not reaching out aggressively to the global market.

In order to facilitate high-tech transfers, it is imperative to face the realities that they cover both defence and civilian technologies. It is here that the major problem of technology transfers lies. This is because as information technologies become the core of military systems, indirect involvement of private industry in defence programmes becomes prevalent and inevitable, what is commonly known as dual-use technologies. Its commercial viability can be high. In India private industries have not yet been given much of an opportunity to develop these technologies. While the public sector in India could still be the core of defence production, participation of the private industry in their respective areas of strength would have to be secured, much more than is being done presently, to encourage self-reliance in design, development and production, especially if a viable indigenous high technology industry is our aim. A case exists for pooling together the expertise and spin-offs from achievement in the private sector to develop major defence systems. This would make for lower costing of high technologies, thereby making it more efficient too.

A major problem is the nomenclature 'dual-use' itself. It connotes an in-built trap, because it essentially assumes the potential for the diversion of technology transferred for civilian use to military use. It serves the purpose of a negotiating lever in the hands of US and FRG to justify denial of high-technology transfer on grounds of its being misused, unless India succumbs to pressures to accept limitations on its sovereign decisions on the use of transferred technology. This concept will have to be redefined especially in the context of the changes taking place in the new generation of technology in what appears to be a unipolar world. Without such a change India would unfortunately continue to receive only obsolescent or an incomplete cycle of high technology and thus lose its own comparative and competitive advantage, over time. In the process it would have to submit to what could be described as a Pavlovian reaction, being at the receiving end of the comparative and competitive advantage of the advanced Western countries, for generations.

Joint ventures in India are not offered the state of the art equipment but state of the available art. These are not commercially viable nor commercially competitive. Consequently, India is becoming a recipient of sunset and not sunrise technologies. This is definitely linked to the concept of dual-use technology transfers. As long as the world was divided between the two super powers, India could afford to adopt strategies by which it could make the best use of the international correlation of forces and try to secure access to or develop technologies in strategic areas. This choice is no longer available. India is facing a resource crunch not only financial but also on the area of strategic technologies. Therefore, it makes better sense to develop technologies which have a wider use in both strategic and non-strategic areas, that is, in the military and civilian areas. It becomes logical and economical to do so. One method would be to explore various options of access to technology and in this, the concept of the best partner ought to be clearly defined. In this work, one has tried to do just that and bring out the fact that the US and FRG are the two best patented partners available in securing access to and tapping for high-tech transfers, through joint ventures, subsidiaries of parent companies, or collaborations.

One advantage of the new liberalisation policy that India is now pursuing is its positive posture towards foreign direct investment in high-tech areas. The Indian government has claimed in June 1993 that the new economic policy has received unprecedented response from foreign investors. During the first four months of 1993 total foreign investment approvals amounted to Rs. 2,970 crore. The total investment offers during the whole of 1991 and 1992 were Rs. 530 crore and Rs. 3,890 crore respectively. Total foreign investment approved during August 1991 to April 1993 amount to Rs. 7,271.86 crore, of which more than 90 per cent has gone to high priority industries. The government has given approval to 114 projects till April 1993, involving foreign investment in excess of 51 per cent of foreign equity and 48 projects have been allowed even with 100 per cent foreign equity. What is more important is the fact that 80 per cent of foreign-tie-ups approved during this period are in high priority industries. Further, in the area of technical collaborations, more than 88 per cent foreign investments are in these high priority industries; such sectors as electrical and electronics equipment, telecommunications, oil, food-processing industries, chemicals, transportation, industrial machinery and hotel and tourism industries.

Giving country-wise investment breakup, the official release said there has been a rise in investment from the USA from Rs. 34.48 crore in 1990 to Rs. 1,231.50

:rore in 1992 and from Japan from Rs. 5 crore in 1990 to Rs. 610.23 crore in 992. This provides strong support to the conclusion of the thesis that both for-:ign direct investment and collaborations act as vehicles of high-tech transfers. In he context of high-tech, we should make full use of the fact that our population of 385 million and a correspondingly large number of scientific and technical manpower ve have, we should be able to strike strategic alliances with transnational compa-ties or even institutions for advanced research. This would ensure the infastructure or technological osmosis. The dual-use approach gives business options to reach out to high-tech companies and attract them on the commercial side. But even here he bottom line is the political, diplomatic and strategic decisions taken by the countries o which these transnationals may belong. Therefore, strategic alliances are essen-ial to secure access to high technology.

At this juncture, it is also important to point out that there are major gaps in cience research, as the publication of the latest survey by the US-based Institute or Scientific Information shows. It concludes that certain areas of research are likely o be monopolised entirely by developing societies. Technology lag in developing ountries, therefore, becomes an outdated cliche. Yet the fact remains that no other ield of knowledge is as inalienably linked with the global shifts in perspectives as hat of scientific research. It is necessary, therefore, for the community of Indian cientists and scientific planners to take a hard look at the national science policy. ince 1980, the two main objectives of our science policy have been indigenization f technologies and reducing the gap between the West and India. It was with these wo aims in mind that the Indian Government set upon Inter-Ministerial Task Force (TF) to take follow-up actions on the Science Congress recommendations. But these re not enough to meet the challenges of the changing global order of science and technology. Two aspects of science and technology in India deserve immediate consideration. The first emerges from the UGC's lack of initiative in making use of the vast manpower base that it has built up in scientific research over the years. The second aspect relates to the lack of coordination between industrial research and scientific research carried out in the national laboratories, creating a gap between research and actual performance. This has to be bridged to get India to be technologically competitive. There is one other lag which is observed especially in defence research-the lack of free flow of information. Secrecy shrouds laboratories. This creates a false smoke screen covering high-tech transfers, which prevents their further evaluation. The Defence Research Development Organisation (DRDO) should provide access to their laboratories, without sacrificing national interests. DRDO should make a serious review of the technologies available for commercial development as well. This would then put an end to the culture of secrecy and promote a wider base for technology. It would bring down the cost of technology in manufacturing advanced materials. In fact, one of the important rationales for dual-technology is that the wider the technological use, the greater will be economies of scale and correspondingly the technology less costly.

These are same of the major concluding issues arising out of the challenges and choices of dual-use technology transfers. The specific technologies which are related to electronics and are important for getting them primarily from US and Germany are:

(i) Parallel Processing Technology: High computing power has been required traditionally in strategic areas where fast reaction and large data processing are involved. This technology needs to be transferred to India as it is useful in image processing, computational fluid dynamics, launch vehicle dynamics, oil reservoir modelling, seismic and meteorological data processing, process control, robotics, astronomy etc. When the Cray super computer was denied to India by the US, because of US Government's licensing policy, India built its own parallel processing computer, Param. A major lesson from this episode for concerned parties is that control over technology can only hold back technological development up to a point and not beyond.

(ii) Software Technology: As seen in this study this area is for both civil and military purposes in education, entertainment, service industry and in weapon's and missiles systems.

(iii) Information Technology: Sometimes encompasses the above, again seen in both civil and military systems. In the Gulf War, it was high profiled with telecommunication systems being observed in distress, resource and service management.

(iv) Photonics: Is an emerging technology which combines the discipline of electronics and optics to achieve ultrafast computing powers, speeds and bandwidths of operation. In civilian application, it is used for high speed computation for simulation modelling. In defence, it is for surveillance and data communication.

(v) Advanced Materials: These materials are required in every field of application. Materials such as composites, high temperature, high conductivity pastes, special chemicals, ultra-pure materials for semi-conductors, and advanced metal alloys, are some examples which are used in both strategic and a number of civilian professional applications.

This is of course not an exhaustive list; it merely enumerates some of the specific emerging technologies.

Having taken two examples in the high-tech areas computers and telecommunications–certain conclusions emerge. India would have to improve its technological ability to make a global impact politically. India is a virtual non-player in the US software market because of: (i) high cost of development and marketing involving high risk; (ii) lack of anticipation and innovation by Indian software developers; and

(iii) high packaging and after-sales service costs. Of course, indigenous production of computers and related items in 1988-89 increased to Rs. 560 crores from a level of Rs. 424 crores in 1987. The major share of production is accounted for by PCs, PC/ATs and mini-systems. The US has definitely contribute to the widening of the Indian network of computers in education, railways and banking. India's strength is in software export, and the India Government is aware of this and has linked imports with exports of computers. To augment software exports, software technology parks have also been set up in Trivandrum, Pune, Bangalore, and Noida.

German firms have also encouraged the Indian computer industry through tie-ups mainly with middle and small enterprises. The failure to develop software in the German language seems to be one major obstacle in a reverse software process. Yet, technology transfer from Germany is continuing.

This rush for software exports by India is seen as reflecting a perceived competitive advantage, the country has in its trained and skilled manpower. The devaluation of the rupee, political stability in India and opening up towards a free market economy would target US and Germany favourably as nations transferring high-tech and as markets for Indian exports. Indian policy is showing a greater economic bias and would have to work towards such a goal. But it should be remembered that only four per cent of the world's information technology is accessible to countries such as India, and Ireland, Singapore, Philippines are competing for this share.

Apart from what has been discussed as part of the computer sector which is pertinent to telecommunications too, telecom needs to be privatized to be comparably competitive as in the US and FRG. Despite a steady rise in equipment and components, as well as in exports, self-reliance in telecom is a myth right now. Much of the transfer of telecom technology takes places through joint ventures, collaborations, licensing and training. Digital switching technology has been identified as the thrust area by India's Telecom Commission. The proposed target of 20 million lines has to be achieved by 2000 A.D., the addition per annum has to be 1.5 million, which is five times its existing rate.

The following options should be pursued for both computers and telecom:

1. appropriate technology acquisition strategy
2. strengthening the component base
3. widening and financing R & D
4. making industry participation profitable
5. strengthening the internal and export markets
6. quality control

However, as repeatedly observed technology transfer does not take place in a vacuum. It has a critical political dimension and it is only a foreign policy based upon realism that can facilitate high technology transfers. A vigorous pursuit of the set objectives through the use of skilful diplomacy may help attain a higher threshold of transferred high technology. Nonetheless, there is no real rationality of high-tech transfers correlating to foreign policy postures. In fact, what becomes amply clear is largely the US attitude and, to some extent, German, in relation to high-tech transfers. This boils down to multilateral controls. The US, apart from its insistence upon intellectual property considers politically India as an regional military power and is, therefore, even more wary of transferring high-tech. Its policy-makers seem to think that if India does not accept multilateral control regimes, such as those of the Nuclear Suppliers Group (NSG), the Missile Technology Control Regime (MTCR), or the Australia Group (AG), this will show India as an even more of a military power, politically independent and technologically self-reliant. The US has till now linked NPT with high-tech transfers. According to US policy-makers India's lack of cooperation has denied it political influence, and, therefore its decisions affect adversely its economic and technological future. It has also kept India from becoming more efficient and competitive globally because of restrictions on its access to technology. It has also precluded India from establishing the high-tech related organisational links which would have contributed, to improved security in the region.

As far as the Missile Technology Control Regime (MTCR) is concerned, its membership has gone up from seven members in 1987, to 21 members now from around the world, and there are several others including Brazil, China, Israel and Switzerland, which voluntarily abide by the MTCR guidelines and annexures. The recent obstruction in the rocket deal hindering the Indian missile programme is due to the fact that India is not an aspirant to the MTCR. Twenty-two countries are now members of the AG, an international forum committed to coordinated export controls on dual-use equipment and substances capable of being used to develop chemical and biological weapons. Finally, there is the Coordinating Committee for Multilateral Export Control (COCOM), an informal inter-governmental body for the control of strategic trade with proscribed destinations situated in the former East Bloc. It is now no longer operative in the same manner and its future has still to be decided. But COCOM was the agency which regulated US export control standards. This has adversely affected Indian computer software as well. US-validated export licenses would be required for all mainframes and all supercomputers.

Germany is not as stringent about COCOM controls, NG, NSG and NPT policies. But Indian policy-makers have to assure the Germans of less bureaucracy and more efficiency. The two case studies, Siemens and Wipro, were meant to show India's capacity for high-technology acquisition and of absorbing and assimilating it even if not to its fullest potential. It would require more than a few interviews, in fact, a long period of studying these firms to locate the advantages and lags in their profile, but as of now both companies project a positive approach which is encouraging.

Our study shows that both economic and foreign policy making are equally important in high technology transfers. India, if it has to be effective on the global scene, must endeavour to bridge the gap between it and the developed nations. With the changing international scenario and the domestic progressive policies, a massive effort, if aggressively pursued, world not fail India in eliciting positive response from the concerned industrial grants, such as the US and the FRG, particularly in regard to high-tech transfers.

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WIPRO ANNEXURE 1

MULTI-LAYER SECURITY SYSTEM NETWORK

Indian Navy required a customised electronic mail facility among several PC users using a EPABX network. A multi-layer security system to protect the central data base from unauthorised access was of primary importance. Wipro developed a solution through a 32 bit UNIX system and customised hardware-software interfaces.

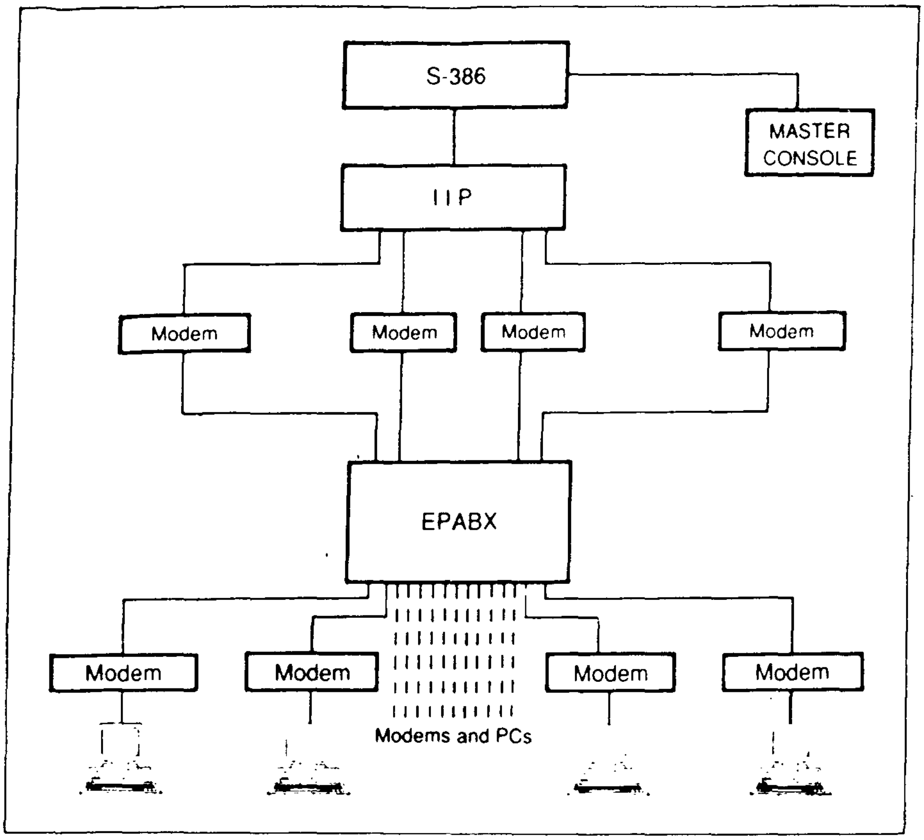
Features

- Central system built around Intel 80386 processor
- Intelligent Isolation Processor (IIP) to provide high isolation facility
- PC level security
- Hand shake protocols for data integrity
- Hardware/firmware based solution
- Isolation from OS to non designated users
- Controlled access to data base
- Easy interfaceability for application programs.

The central computer system is based on a 32 bit high performance 80386 processor and UNIX Operating System executing network applications. IIP is connected to the system as an intermediate system for PC connectivity through EPABX. The PCs are connected to the IIP through dial-up modems and a private EPABX network.

A customised communication and security package on the PCs under DOS is a pre-requisite for connectivity to the central system. This software cannot be copied except through physical intervention by the designated persons.

The Intelligent Isolation Processor forms a part of the network system and is built around a 16 bit processor. It supports hand shake and error recovery. The firmware on IIP and Network Control Program (NCP) provide access for the users' selected applications. Security levels are verified, before the access to the desired application is permitted.



Multi Layer Security Network can be modified for a variety of applications where a number of users need to access a central system with adequate protection for programs and data base.

For further information, please write to :

WIPRO
INFORMATION TECHNOLOGY LIMITED

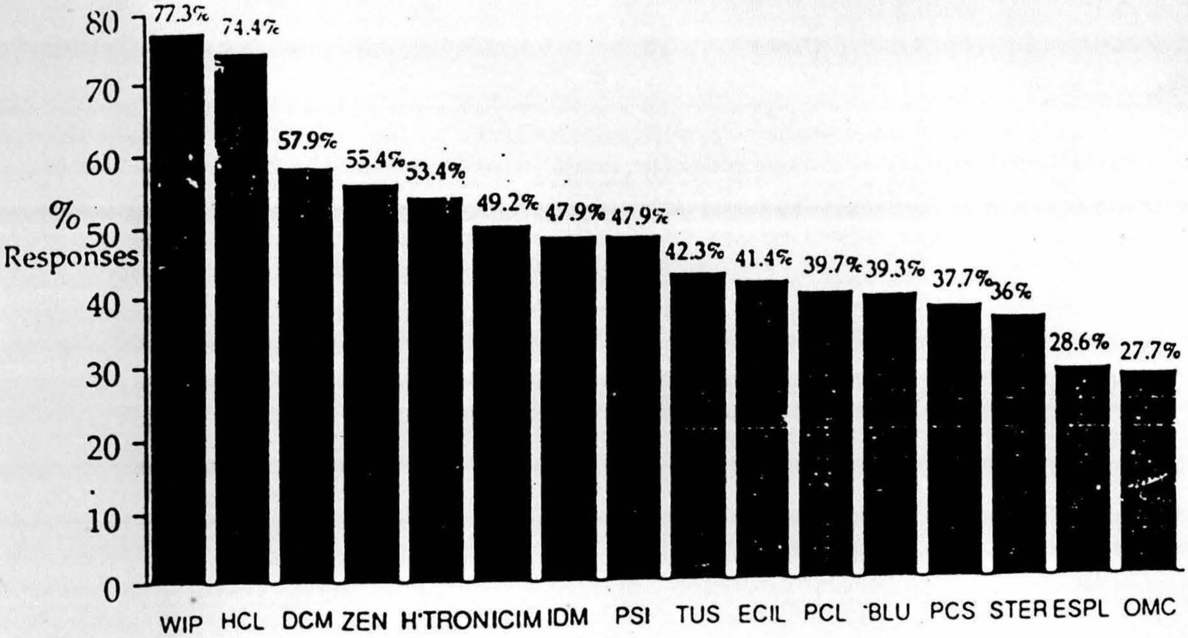
Systems Engineering Division
88, M.G. Road,
Bangalore 560 001, India
Telephone : 91-812-569 622
Telex : 81-845-8356
Telefax : 91-812-565657

VENDOR RATING

Sixteen companies were listed in the questionnaire and users were asked to rate them on a scale of 1 to 10 (where 1 is very poor and 10 is excellent).

The results have been shown by two graphs. The first graph indicates the number of users who ranked the particular company. The second graph indicates the user rating. The two graphs should be interpreted together. A company may have a very high rating but might be known only to a few users.

VENDOR AWARENESS GRAPH I

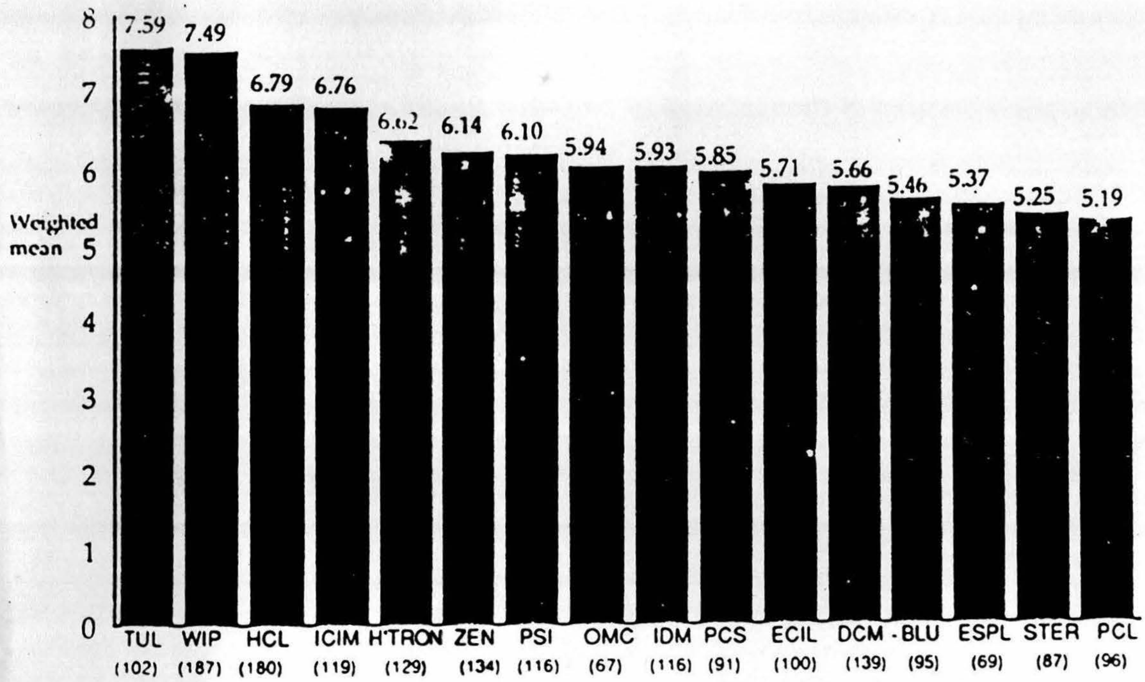


The users displayed a very high degree of awareness of WIPRO & HCL but were less aware of ESPL & OMC.

USER RATINGS ON VENDOR

(Scale of 1-10, 1 = very poor 10 = excellent)

VENDOR RATING GRAPH II



In terms of rating, Tata Unisys figured prominently followed by Wipro and HCL, while IDM and PCS were at the lower end.

* Figures in parenthsis indicate the Number of users who rated the individual companies.