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**A PLANNED APPROACH FOR THE
GROWTH OF ELECTRONICS
INDUSTRY — A CASE STUDY
FOR INDIA**

STPI Background Paper No. 8

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A PLANNED APPROACH FOR THE GROWTH OF
ELECTRONICS INDUSTRY -
A CASE STUDY FOR INDIA

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A Report Submitted to the Dept. of Science and Technology
for S.T.P.I. Programme

Electronics Commission, IPAG
Technology Development and
Implementation Division

STPI Background Paper No. 8

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A PLANNED APPROACH FOR THE GROWTH OF
ELECTRONICS INDUSTRY - A CASE STUDY FOR INDIA*

1.0 The Background

The era of rapid development of the electronics industry in India was ushered in with the setting up of the Electronics Committee by the Government of India. The Chairman of the Committee was Dr. Homi Bhabha and the members were Dr. S. Bhagavantam, Shri A.S. Rao and Dr. Vikram A. Sarabhai.

The Report of the Bhabha Committee which was submitted in

* A Report Submitted to the Department of Science and Technology for S.T.P.I. Programme.

1966 brought forth the need for intensified growth of this industry along predominantly indigenous lines. The report presented a master plan for the development of the industry. It was estimated that the annual capacity in crores of rupees that will be reached in 1975 would be Rs. 300 crores in the pessimistic limit and Rs. 500 crores in the optimistic limit. The Bhabha Committee for the first time quantified the problems and prospects of the Indian Electronic Industry. Various sectors likely to be of increased importance in future were identified. The report emphasized that a viable base for the manufacture of professional components needs to be established expeditiously to support the growing equipment needs. The then existing electronic industry was reviewed and recommendations were made. The total investment of Rs. 170 crores was envisaged in the electronic industry during the ten-year period 1965-1975.

The developments in the field of electronics since the publication of the Bhabha Committee report were discussed at the National Conference on Electronics in early 1970. The conference brought together planners, manufacturers and users to discuss the industrial and import licensing policies, financial participation, role of the small scale sector etc. Many viewpoints were expressed during the conference. After reviewing the progress of the industry, since the submission of the Bhabha Committee Report, the panels of experts constituted during the National Conference emphasized that it is imperative to set up an organization to review the entire field of electronics in view of the fast changing technology and to recommend ways of achieving self-sufficiency in the shortest possible time and the best possible manner. It was also emphasized that such an organization should be free from all nonessential restrictions and inelastic rules.

Recognizing the importance of developing an integrated and

self-reliant electronics industry in the country, and the need for rapid progress in this regard, the Government of India constituted a separate Department of Electronics with effect from 26th June 1970. In February 1971, Government constituted the Electronics Commission, under the Chairmanship of Professor M.G.K. Menon, F.R.S., who is also the Secretary to the Government of India in the Department of Electronics.

On the composition of the Electronics Commission, the Government Resolution states:

- i) The Electronics Commission shall consist of full-time and part-time members. The total number of members shall be not less than four but not more than seven.
- ii) The Chairman of the Electronics Commission will also be Secretary to the Government of India in the Department of Electronics.
- iii) A Member of the Commission will be the Member for Finance who shall also be ex-officio Secretary to the Government of India in the Department of Electronics in financial matters.

The other members of the Commission were:

- 1) Shri T. Swaminathan,
Cabinet Secretary.
- 2) Shri B.D. Pande,
Finance Secretary

- 3) Shri M.S. Pathak,
Member, Planning Commission
- 4) Shri A.S. Rao
Managing Director
Electronics Corporation of India Ltd., Hyderabad.

In the Resolution setting up the Electronics Commission it is stated:

"Government attaches the highest importance to the development of an integrated and self-reliant electronics industry in the country, as rapidly as possible. Electronics occupies a key position in modern science and technology. It has a vital role to play in the fields of atomic energy, communications, defence, education, entertainment and space technology. It is assuming increasing importance in the monitoring and control of production processes in the engineering, chemical and metallurgical industries. Because of its dynamic character, its pervasive nature and its significant impact on science, industry and society, electronics is today in the vanguard of technological progress. Technological progress and obsolescence are both very rapid in this field. An intensive promotional effort relating to both production and research and development is, therefore, essential to ensure a rapid growth of self-confidence and of indigenous capabilities.

The Electronics Commission has been charged with full responsibility to review the entire field of electronics with regard to research, development and industrial operations, with

full authority to formulate policies in this field and to direct implementation, on sound technical and economic principles, of all measures, both promotional and regulatory, that are necessary for the country to attain self-reliance in the shortest possible time and in the best possible manner.

In November 1972 Shri T. Swaminathan retired from his position as Cabinet Secretary; Shri B.D. Pande took over as Cabinet Secretary and M.R. Yardi as Finance Secretary.

The Commission was reconstituted with effect from 21/11/1972 and its members were:

1. Prof. M.G.K. Menon, Chairman
2. Shri B.D. Pande, Cabinet Secretary
3. Shri M.S. Pathak, Member, Planning Commission
4. Shri A.S. Rao, Managing Director, ECIL, Hyderabad
5. Shri M.R. Yardi, Finance Secretary.

The reconstituted Commission held office until 30th June 1973.

The Commission was reconstituted with effect from 1/7/1973 with Prof. M.G.K. Menon as Chairman and the following as members:

1. Shri P.N. Dhar, Secretary to the Prime Minister;
2. Dr. B.D. Nag Chaudhuri, Scientific Adviser to Raksha Mantri;
3. Shri A.S. Rao, Managing Director, ECIL, Hyderabad; and
4. Shri M.R. Yardi, Finance Secretary.

In 1974, Shri H.N. Ray, Finance Secretary took over as Member (Finance) of the Electronics Commission.

Shri Ashok Parthasarathi joined the Department of Electronics in February 1975 as Secretary, Electronics Commission and ex-officio Joint-Secretary to the Department.

On October 1, 1975, the Commission was reconstituted with Prof. M.G.K. Menon as Chairman and the following as members:

- 1) Lt. Gen. K.S. Garewal
Chairman, Coal Mines Authority
- 2) Shri C.R. Subramanian
Chairman-cum-Managing Director
Bharat Electronics Ltd., Bangalore
- 3) Shri A.S. Rao
Managing Director
Electronics Corporation of India Ltd., Hyderabad.
- 4) Shri H.N. Ray
Finance Secretary
Ministry of Finance

1.1 Immediate Tasks Before the Electronics Commission

The Electronics Commission is involved in the following immediate tasks:

- a) to make an assessment of the present requirement and those over the future (during the next 5 - 10 years) in all sectors of electronics including equipment, components and materials;
- b) to make an assessment of the imports of all types in the

field of electronics;

- c) to make an assessment of the installed capacities, letters of intent issued and intrinsic manufacturing capabilities in the public and private sector and the future plans thereof over the next few years;
- d) to determine the manner in which additional manufacturing capability should be generated in the public sector and the private sector;
- e) to determine the extent of existing activity in the scale sector, their future plans and the action necessary to promote faster growth in that sector;
- f) to make an assessment of the present R&D capabilities in the country and the manner in which these should be coordinated, directed, developed and funded; and to determine the manner in which new R&D programmes could be developed in identified areas with the help of scientists in India and those who could be brought back from abroad;
- g) to make an assessment of the existing available manpower and training facilities at various levels (skilled workers and technicians, supervisory staff and engineers and scientists for R&D, management etc.) and to assess the future manpower requirements needed for the planned growth of the industry and determine the manner in which necessary skills could be imparted and manpower made available as required;
- h) to assess the present export efforts and the steps necessary to promote exports such as incentives simplification of

procedures and the setting up of wholly export-oriented industries including operations such as free trade zones;

- i) to make an assessment of the plans of each State for development of the electronics industry and determine the manner in which support, advisory, technical and financial, could be provided for full growth of the potential of each State in this field, with a view to ensuring wide dispersal of this industry throughout the country;
- j) to determine the manner in which support, financial and advisory, could be provided to engineers and technicians in India and those willing to return from abroad to set up technology oriented and economically viable industrial projects in electronics;
- k) to coordinate efforts for the rapid development of electronics in vital and strategic areas such as defence and communications.

One of the major activities of DOE is initiating, coordinating and monitoring suitable promotional measures designed to meeting the electronics requirements of various major sectorwise users on the basis of maximum possible indigenous effort.

The DOE in coordination with the office of the Development Commissioner, Small Scale Industries (DCSSI) approves and monitors phased manufacturing programmes of electronics units in the Small Scale Sector.

The DOE is mainly responsible for day-to-day decisions relating to the industry; implementation of various regulatory and promotional measures; and in maintaining links with parliament and

various Government departments, agencies and institutions at the Centre and in the States.

1.2 Allocation of Duties to IPAG

The information, Planning and Analysis Group (IPAG) was set up in 1971 for assisting the Electronics Commission in analyzing various aspects related to the Electronics Industry.

The IPAG has complete responsibility for:

- a) Organizing the collection, documentation retrieval and dissemination of information on all aspects of the industry assisted by a computer-based information system.
- b) Analyzing the statistical and technical information with a view to evolving optimal long-term strategies for capital investment, technology acquisition, research and development, import substitution and export promotion.
- c) Planning the industry in the long-term by periodically updating the Bhabha Committee Report on Electronics and evolving viable organizational mechanisms of implementation.
- d) Bringing out information reports, analysis reports and white papers for providing the background material for policy-making by the Electronics Commission and for the use of the Department of Electronics.
- e) Bringing out periodicals and brochures for providing useful information to those concerned with the industry.
- f) Providing background material and coordination efforts for

planning panels constituted by the Electronics Commission and arranging for necessary follow-up planning.

Fig. 1.1 gives the organizational chart for Electronics Commission, Department of Electronics and IPAG.

Tables 1.2 to 1.5 give lists of Technical Analysis Reports, Technical Information Reports, Manpower Reports, Area Survey Reports and Technical Panel Reports completed up to December 1975 since its inception.

The IPAG was also given the responsibility of updating the Bhabha Committee Report. This task was completed recently and a Report titled "Perspective Report on Electronics in India" has been released to the public.

The IPAG Headquarters is located at New Delhi. The IPAG has three regional Cells at Bombay, Calcutta and Madras which coordinate the activities of Electronics in those regions with the Headquarters. These cells also collect the import statistics on electronic items.

1.3 National Advisory Committee on Electronics (NACE)

In order to facilitate a regular exchange of ideas and mutually beneficial interactions among all concerned agencies in Government and outside Government, the Electronics Commission set up a National Advisory Committee on Electronics in September 1973, under the Chairmanship of Prof. M.G.K. Menon, NACE has been set up to act as a broad-based forum for discussion on all aspects relating to the growth and development of electronics industry. It consists of 80 members drawn from Government Departments, Associations of Industry and Trade, Academic Institutions, Re-

search Laboratories, Public Sector undertakings and Small Scale Sector. The Committee is responsible for discussing problems of general interest relating to research, development, industrial licensing, industrial operations, education, training and manpower, role of various sectors etc., and provide a broad-based set of views to the Electronics Commission and the Department of Electronics on specific problems which may be brought to the notice of the committee from time to time.

The Committee will be meeting at least once in a calender year. The first meeting was held on March 11 and 12, 1974 at New Delhi. The First Plenary Session discussed the Fifth Five-Year Plan proposals formulated by the Electronics Commission and the Department of Electronics and accepted by the Planning Commission. Three Working Groups were formed to discuss problems of the industry, strategy for exports and training and manpower. The working groups discussed respective problems at length and made specific recommendations.

The research and development plan drawn up for electronics was also discussed. A large number of valuable suggestions by the user sector in regard to export promotion, licensing policies, marketing etc., were received. The second meeting of NACE was held in January 1975. The main topic of discussion was the role of the State Industrial Development Corporations. The Department of Electronics, in consonance with its policy of diversifying the electronics industry throughout the country, has encouraged and financed setting up of Test and Development Centres at functional electronic estates of various states. The second meeting of NACE afforded a valuable opportunity to the Department of Electronics for obtaining information through this interaction and discussions with representatives from different sectors of electronics.

1.4 National Radar Council (NRC)

It has been recognized by the Electronics Commission that the Radar requirements in the country in numbers (of equipment) and financial terms are sizeable; and that this particular requirement is for a single class of equipment of strategic importance. It has been felt that the manufacture, design and development, as well as research in the area of radars, needs to be given a high degree of national priority.

With a view to ensuring proper coordination of the various activities in this field so as to meet the defence and civil requirements in an integrated manner and on the basis of maximum self-reliance, a National Radar Council (NRC) has been set up under the chairmanship of the Chairman, Electronics Commission. The NRC is composed of senior officers from major agencies concerned with the development, and users of radars, such as D.R.D.D., Department of Defence Production, Defence Services, Department of Space, Civil Aviation, etc.

The terms of reference of the National Radar Council are as follows:

- a) To formulate, periodically review and update an integrated Radar Systems and Components' Plan covering both defence and civil requirements, taking into account plans and programmes already in existence.
- b) To prepare and ensure the implementation of technology plan to meet the nation's short and long-term requirements of Radars.
- c) To consider, as part of the technology plan, all proposals

for import of technology and foreign collaboration relating to radars and allied equipment.

- d) To formulate, also as part of the technology plan, an integrated programme of R&D, including futuristic aspects and undertake the promotion and coordination needed to have that programme implemented.
- e) To coordinate production aspects of Radar and allied equipment especially so as to ensure, standardization of components and building blocks to generate sub-assemblies and sub-systems that can be used on an interchangeable basis for a family of radars.
- f) To relate the above tasks to ensure that specific user requirements are met on the basis of maximum self-reliance, and
- g) Generally to act as focal point to ensure that the direction, pace and quality of the over-all effort in the field of Radars is such that the Nation as a whole benefits from the efforts of the various concerned agencies.

FIG. 1.1

ORGANIZATIONAL CHART FOR ELECTRONICS COMMISSION
AND DEPARTMENT OF ELECTRONICS

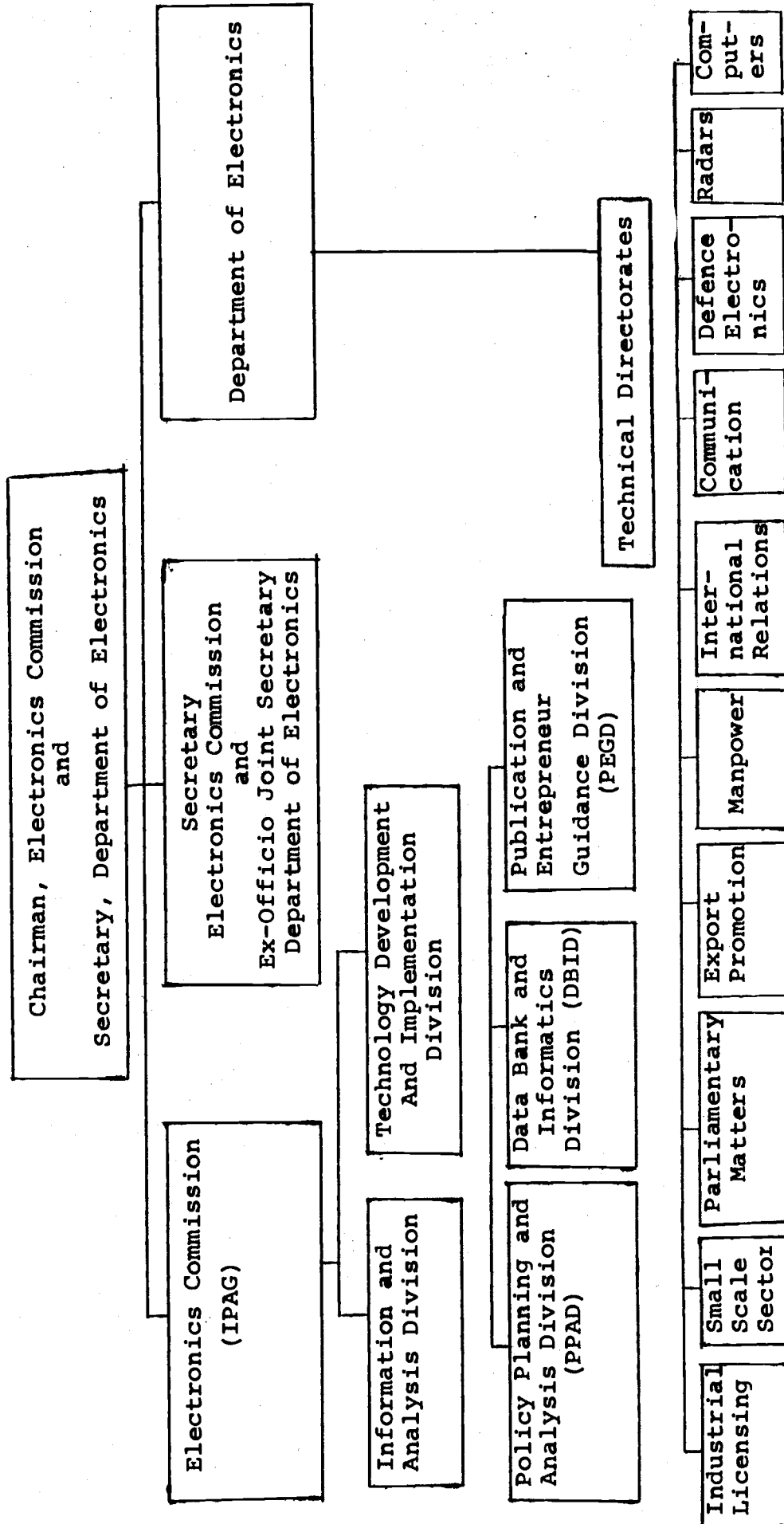


TABLE 1.1

TECHNICAL ANALYSIS REPORTS

1. Profile of competition in the radio industry in the organized sector.
2. Economical Scale of production for the television receiver industry under Indian conditions.
3. Analysis of computerization in the Bombay-Poona region.
4. Some Technological and Regulatory problems associated with the indigenous manufacture of magnetic tapes.
5. Analysis of the factors governing the penetration of the rural radio market.
6. Economics of regional computer centre for developing countries.
7. Planning for indigenous production of minicomputers and programmable calculators. Part-1 - Demand Profile.
8. Planning for indigenous production of minicomputers and programmable calculators. Part-2 - Peripherals.
9. Planning for indigenous production of minicomputers and programmable calculators. Part-3 - Level of Integration.
10. Planning for indigenous production of minicomputers and programmable calculators. Part-4 - Production Planning.
11. Planning for indigenous production of minicomputers and programmable calculators. Part-5 - Software and Manpower.
12. Planning for indigenous production of minicomputers and programmable calculators. Part-6 - Financial Analysis.
13. Planning for the promotion of minicomputer applications in India. Part-1 - Production of capital equipments.
14. Planning for the promotion of minicomputer applications in India. Part-2 - Telephone Network.
15. Analysis of Elasticity of urban consumers of TV receivers.

TABLE 1.1 continued

16. Planning for the Semiconductor Industry in India.
17. A first approximation analysis of demand and investment profile for electronics and communication during the decade 1971 - 1981.
18. An approach to standardization in the electronics industry.
19. A normalized demand profile for electronic materials.
20. A technoeconomic Analysis of two-way communication equipments.
21. An approach to the Indigenization in the computer peripheral industry.
22. Electronic components industry - An analysis.
23. Microwave Solid State Devices & Materials - An analysis.
24. An analysis of import of Electronic goods during 1972 - 1973.
25. Planned Introduction of Medical Electronics to Hospitals in India. Part-1 - General Analysis.
26. Optimal size of firms in the Indian Electronic Industry.
27. Techno-Economic Analysis of possible strategy for the analysis of Penetration of Rural Radio Market.
28. Process Control Instrumentation: problems during the nucleation of the industry.
29. A strategy for antenna manufacture in India.
30. Potential geographical locations for setting up Electronic Industries in India.
31. Analysis of the factors governing the location of a joint Real-time computer for Air-India and Indian Air Lines.
32. Planning for the indigenous development and production of instrument control components.
33. Planning for the indigenous development and production of TV test instruments.

TABLE 1.1 continued

34. A Sequential Optimal Decision model for the R&D plan in Electronics.
35. Planning for the indigenous development and production of microwave test and measuring instruments.
36. A Techno-economic analysis of waveguides manufacture.
37. Preliminary decision of a computer-based cultivator information systems.
38. Analysis of technical and organizational requirements of computerization in Indian Steel plants.
39. Improving yield of semiconductor devices.
40. Capital equipment and primary material requirements for the semiconductor industry.
41. Technological alternatives and demand profile for electronic equipment in the Indian pulp and paper industry.
42. Energy Crisis: An analysis of its impact on the Indian Electronics Industry.
43. Cost benefit analysis of foreign equity participation in the Indian Computer Industry.
44. Planning for the manufacture of printed circuit boards in India.
45. Materials for electronics industry in India: An analysis.
46. Custom manufacture of capital equipment for the electronic industry in India.
47. An optimization model for the location of receiver/rebroadcast stations for the Indian Domestic Satellite System.
48. Strategy for the indigenous production of microwave tubes.
49. A strategy for transreceiver manufacture.
50. A preliminary analysis of export possibilities of selected electronic items.

TABLE 1.1 continued

51. High purity alloys in electronics.
52. Environmental pollution monitoring: Planning and Implementation strategy for India.
53. Connector Industry in India: Problems and prospects.
54. Materials for electronics component industry - glasses and ceramics.
55. Materials for electronics components industry - metals and alloys.
56. F.M. Broadcast: The future of radio industry in India.
57. Mining electronics - prospects for India.
58. Agri-electronic instrumentation - its relevance to Indian agriculture.
59. An analysis of tethered ballon communication system and its application to India.
60. A case study of computer requirements for large scale banking.
61. Modernization of signalling and traction facilities in Indian Railways: a perspective analysis.
62. The march tever.
63. A comparative study of display devices from the indigenous angle.
64. Control and Instrumentation in Indian fertilizer industry - current status and strategy for progressive indigenization.
65. Electronic Aids to Marine Activities: the Indian scene.
66. Planning for Automation in Semiconductor Industry in India.
67. Techno-economics of alternative power supplied for community TV reception.
68. Maritime Communication.
69. Power semiconductor devices - their role in the industry.

TABLE 1.1 continued

70. Indian Railway's modernization programme in telecommunication facilities vis-a-vis indigenous capabilities.
 71. An analysis of subcontracting software on a modular basis.
 72. Low-cost peripherals: their relevance to the Indian computer industry.
 73. Strategy for progressive indigenization of electronic materials.
 74. Cost effectiveness of Data communication via satellites.
 75. Formulation of a development Project for automatic finger print identification.
 76. Indigenous manufacture of Gallium for Electronics Industry.
 77. Satellite Group Station Antennas: A Techno-economic analysis.
 78. Development Strategy for Facsimile System in India.
 79. Current profile and suggested promotional measures for electronic test and measuring instruments industry.
 80. Digital satellite communication for computer network links
 81. Current Status and Growth Prospects of TV Industry in India.
-

TABLE 1.2

TECHNICAL INFORMATION REPORTS

1. Structure and function of Electronics Commission and the Department of Electronics.
2. Structure and function of IPAG.
3. Background information for new entrepreneurs in the Electronics industry.
4. Research trends up to 1971 in data links and remote processing.
5. Trends in the application of electronics and communication technology to railway and other transport networks.
6. Comparison of large computer systems suitable for regional computer centres.
7. Research trends up to 1971 in transducer technology.
8. Technology trends up to 1971 in integrated circuit production.
9. Statistical Outline of Electronics Production during 1965-1971.
10. Market survey on Telemetry and Telecontrol system.
11. Government organization for co-ordinating the electronics industry in France.
12. Information Processing at IPAG: A framework for Computerization.
13. Ga As Semiconductor Technology: State-of-art and perspective technological alternatives.
14. Navigational Aids: State-of-art and perspective technological alternatives.
15. Telecommunications: State-of-art and perspective technological alternatives.
16. Medical Electronics Equipments: Information to users.

TABLE 1.2 continued

17. Industrial Electronics and Control: Technological trends and alternatives.
 18. A classification for the Electronics industry.
 19. Product Identification in the Electronics Industry.
 20. Energy Crisis: An annotated bibliography.
 21. Potential application of remote sensing to economic development in developing countries.
 22. Computers in medicine.
 23. Analytical Instruments: Technological trends and alternatives.
 24. Recent trends in international telecommunication.
 25. Agri-Electronic Instrumentation - An appraisal of the technique and methods.
 26. Credit facility for public sector imports.
 27. Environmental quality monitoring instrumentation: a critical appraisal of current methodologies, research trends, and future needs.
 28. Mass media of education: a comparative study of radio and television.
 29. Electronics in flood control and flood forecasting.
-

TABLE 1.3

MANPOWER REPORTS

1. Manpower training for the semiconductor industry.
 2. Manpower profile for implementing the Fifth Five-Year Plan for electronics and communication.
 3. The role of intensive training schemes for plan implementation.
 4. Report of the Committee on Small and Medium Entrepreneurs: Implementation Strategy for electronics and communication.
-

TABLE 1.4

AREA SURVEY REPORTS

1. A Perspective Analysis of Trade and Technology Cooperation in Electronics with Hungary.
2. A Perspective Analysis of Trade and Technology Cooperation in Electronics with Australia.
3. A Perspective Analysis of Trade and Technology Cooperation in Electronics with U.S.S.R.
4. A Perspective Analysis of Trade and Technology Cooperation in Electronics with France.
5. A Perspective Analysis of Trade and Technology Cooperation in Electronics with Poland.
6. A Perspective Analysis of Trade and Technology Cooperation in Electronics with Japan.
7. A Perspective Analysis of Trade and Technology Cooperation in Electronics with German Democratic Republic.
8. A Perspective Analysis of Trade and Technology Cooperation in Electronics with Canada.
9. A Perspective Analysis of Trade and Technology Cooperation in Electronics with Netherlands.
10. A Perspective Analysis of Trade and Technology Cooperation in Electronics with Yugoslavia.
11. A Perspective Analysis of Trade and Technology Cooperation in Electronics with Federal Republic of Germany.
12. A Perspective Analysis of Trade and Technology Cooperation in Electronics with Czechoslovakia.
13. Electronic Exports to Gulf Countries: A Preliminary Survey.
14. A Perspective Analysis of Trade and Technology Cooperation in Electronics with Denmark.
15. A Perspective Analysis of Trade and Technology Cooperation in Electronics with Rumania.

TABLE 1.4 continued

16. A Perspective Analysis of Trade and Technology Cooperation in Electronics with the United Kingdom.
 17. A Perspective Analysis of Trade and Technology Cooperation in Electronics with Italy.
 18. A Survey of Electronics Industry in the People's Republic of China.
 19. A Perspective Analysis of Trade and Technology Cooperation in Electronics with Latin American Countries.
 20. A Perspective Analysis of Trade and Technology Cooperation in Electronics with Bulgaria.
 21. A Survey of Electronics Industry in South Korea.
 22. Prospects for Trade and Technology Cooperation in Electronics with Iran.
 23. Prospects for Trade and Technology Cooperation in Electronics with Laos.
 24. Prospects for Trade and Technology Cooperation in Electronics with Burma.
 25. Prospects for Trade and Technology Cooperation in Electronics with Afghanistan.
 26. Prospects for Trade and Technology Cooperation in Electronics with Malaysia.
 27. Prospects for Trade and Technology Cooperation in Electronics with Bangladesh.
 28. Prospects for Trade and Technology Cooperation in Electronics with Indonesia.
 29. Prospects for Trade and Technology Cooperation in Electronics with Singapore.
 30. A Perspective Analysis of Trade and Technology Cooperation in Electronics between India and the Andean Group of Latin American Countries.
 31. Prospects for Trade and Technology Cooperation in Electronics with Thailand.
-

TABLE 1.5

LIST OF TECHNICAL PANELS SET UP BY INFORMATION, PLANNING
AND ANALYSIS GROUP TO GO INTO FOLLOWING QUESTIONS

1. Priority in the development of Medical Electronic Equipment and Promotional measures.
 2. Guidelines for indigenous production of control components. This panel had two sub-groups viz:
 - a) Panel on industrial drives and controls.
 - b) Panel on power station load despatch and telemetry.
 3. Guidelines for the indigenous production of TV test instruments.
 4. Guidelines for the production of ultra pure materials for electronics.
 5. Guidelines for the production of chemicals and plastics for electronics.
 6. Guidelines for indigenisation of microwave components manufacture.
 7. Guidelines for the indigenous production of passive components.
 8. Guidelines for the indigenous production of mechanical and electrical components.
 9. Guidelines for the manufacture of special electron tubes.
 10. Guidelines for standardization in electronics industry.
 11. Guidelines for evolving funding procedures for R&D Projects to be funded by Electronics Commission.
 12. Panel on Capital equipment for the Electronics Industry.
-

2.0 Fifth Five-Year Plan for Telecommunication & Electronics Industry

The Planning Commission set up a Task Force in 1972 on Telecommunications and Electronics Industry, at the instance of the Steering Group on Engineering Industries. The Task Force concerned itself with the broad area of formulating policies and programmes relating to the overall plans of various sectors of the Electronics Industry. The Task Force on Telecommunications and Electronics Industry worked through Eight Working Groups in the following areas:

- a) Consumer electronics
- b) Mass Communication
- c) Telecommunications
- d) Aerospace electronics and Communication
- e) Radar and defence systems
- f) Computers, controls and industrial electronics
- g) Instruments and Instrumentation
- h) Components and materials.

The IPAG of Electronics Commission provided the analytical and secretarial support for these Working Groups and was responsible for the final preparation of the Task Force Report. This Report formed the basis of discussions between the Department of Electronics, Planning Commission and Ministry of Finance concerning the Fifth Five Year Plan for Telecommunications & Electronics.

The local consumption and Investment pattern for the growth of various sectors of Electronics Industry during the Fifth Five Year Plan as worked out by the Working Groups of the Task Force are given in Tables 2.1 to 2.9.

Based on the Task Force Report, the Department of Electronics in July 1973 prepared the draft plan for Electronics for the Fifth Five Year Plan. Two profiles, a total profile and a difference profile was prepared as part of the fifth plan document. In the total profile, the electronics' activity included in the plans of Ministry of Communications, Ministry of Defence, Ministry of Information & Broadcasting, Ministry of Industrial Development, Ministry of Civil Aviation, Atomic Energy Commission and Space Commission were also included. Thus this profile gave the total profile of electronics activities in the country under various Ministries/Departments. In the Difference Profile all the activities proposed to be started under the Department of Electronics were enumerated.

The plan report of July 1973 submitted by the Department of Electronics was discussed in the meeting of the Planning Commission offered a number of suggestions and modifications which was subsequently incorporated in the revised report.

The revised Total and Difference profiles are indicated in Tables 2.10 and 2.11 of the activities envisaged by the Department of Electronics, some activities have already been started and others are in the process of being initiated.

A Trade and Technology Liaison limit which was proposed to handle the import and export trade between India and East European Countries has already been started as a corporation called Electronics Trade and Technology Development Corporation (ETTDC). Apart from carrying out import and export trade in electronics between India and East European Countries, this corporation in the public sector has also built an information base and has streamlined technical and procedural difficulties encountered in this trade.

Another activity which is to be commissioned shortly is in the area of Semiconductors. In view of the rapid technologies advancement in the Semiconductor devices area, the need for a new semiconductor devices complex in public sector dedicated to the production of these devices was recognized; along with the production activities, it was recognized that R&D semiconductor devices involving high level technology, e.g. MOS-LSI technology, LED technology, SC memories, high density packaging technology etc. was also necessary. A complex for production of these devices and to carry out R&D is to be set up shortly.

Yet another activity which is soon to be started is a corporation for computer maintenance. The Electronics Commission has advocated the setting up of a centralized maintenance agency for all imported computers in the country. This is designed to build up self-reliance in maintenance of systems and to carryout system engineering improvements in the system.

A list of the important manufacturing and promotional activities which are envisaged to be initiated in the Fifth Five Year Plan is given below:

- Custom manufacture of special tubes
- CPU and peripheral controllers
- Basic peripherals
- Software Development
- Automation promotion centre
- Promotion of control components
- Production of microwave components and Instruments
- Custom production of Capital Equipment
- Two-way communication Equipment
- Test and Development facilities
- Standardization Activities

Stage agency for rural market promotion

High Technology and medical electronics instruments
development and production.

TABLE 2.1

LOCAL CONSUMPTION PATTERN FOR TELECOMMUNICATION AND ELECTRONICS INDUSTRY

(All figures in Rs. Crores)

No.	Items	1974-75	1975-76	1976-77	1977-78	1978-79
1	Consumer Electronics	88	99	118	135	150
2	Mass Communication	4.9	10.2	115.2	20.6	23.6
3	Telecommunication	81	107	144	201	226
4	Aerospace Electronics and Communication	8	10	12.3	15.8	18.5
5	Radar & Defence Systems	70	85	114.5	155	169.5
6	Computers, Control Industrial Electronics	20.5	28	38	50.5	60
7	Components	80	101	125	166.5	190.5
	Total Equipment	272.4	339.15	442.0	577.85	647.65
	Total Components	80	101	125	166.5	190.5

TABLE 2.2

INVESTMENT PATTERN FOR CONSUMER ELECTRONICS

(All figures in Rs. Crores)

No.	Item	1974-75	1975-76	1976-77	1977-78	1978-79
1	Total Local Consumption	88	99	118	135	150
2	Total direct imports of products/parts	2.5	2.5	2.5	2.5	2.5
3	Export through local production	4.5	5.5	6.5	9.5	12.5
4	Export through Free Trade Zones	12.5	16.5	24.5	32.5	41
5	Total local production	90	102	122	142	160
6	Total investment for local production	9.0	9.0	6.5	4.5	3.0
7	FE investment on purchase of Foreign know-how and Capital equipments	4.5	4.0	3.0	2.0	2.0
8	FE investment of indigenous development of know-how and capital equipments.	0.5	0.5	0.5	0.5	0.5

TABLE 2.3

INVESTMENT PATTERN FOR MASS COMMUNICATION

(All figures in Rs. Crores)

No.	Item	1974-75	1975-76	1976-77	1977-78	1978-79
1	Total Local Consumption	4.9	10.15	15.2	20.6	23.65
2	Total Direct Imports of products/parts	0.15	0.25	0.35	0.4	0.45
3	Export through Local Production	0.25	0.6	1.15	1.8	2.8
4	Export through Free Trade Zones	0.7	1.7	3.5	5	3.0
5	Total Local Production	5	10.5	16	22	26
6	Total Investment for Local Production	0.45	0.75	0.60	0.65	0.45
7	FE investment of Purchase of Foreign know-how and Capital Equipments	0.2	0.35	0.20	0.2	0.15
8	FE Investment on Indigenous Development of Know-how and Capital Equipments	0.05	0.05	0.05	0.05	0.1

TABLE 2.4
INVESTMENT PATTERN FOR TELECOMMUNICATION
(All figures in Rs. Crores)

No.	Item	1974-75	1975-76	1976-77	1977-78	1978-79
1	Total Local Consumption	81	107	144	201	226
2	Total Direct Import of products/parts	20	25	20	15	10
3	Export through Local Production	-	2	4	6	9
4	Export through Free Trade Zones	-	-	1	2	4
5	Total Local Production	61	84	129	192	225
6	Total Investment for Local Production	25	30	25	17	12
7	FE Investment on Purchase of Foreign Know-how and Capital Equipments	7	8	5	4	3
8	FE Investment on Indigenous development of know-how and Capital Equipments.	1	1	1	1	1

TABLE 2.5

INVESTMENT PATTERN FOR AEROSPACE ELECTRONICS & COMMUNICATIONS

(All figures in Rs. Crores)

No.	Item	1974-75	1975-76	1976-77	1977-78	1978-79
1	Total Local Consumption	8	10	12.3	15.75	18.5
2	Total Direct Imports Products/ Parts	2	2.5	1.5	1	1
3	Export through Local Production	-	-	0.2	0.25	0.5
4	Export through Free Trade Zones	-	-	0.1	0.1	0.2
5	Total Local Production	6	7.5	11	15	18
6	Total Investment for Local Production	1	1.5	0.6	0.4	0.3
7	FE Investment on Purchase of Foreign know-how and Capital Equipments	1	0.6	0.15	0.15	0.1
8	FE Investment on Indigenous De- velopment of know-how and Capital Equipments	0.05	0.15	0.1	0.1	0.1

TABLE 2.6

INVESTMENT PATTERN FOR RADAR & DEFENCE SYSTEMS

(All figures in Rs. Crores)

No.	Item	1974-75	1975-76	1976-77	1977-78	1978-79
1.	Total Local Consumption	70.	85	114.5	155.	169.5
2.	Total Direct Import of Products/ Parts	18.	22.	14.5	10.5	88.5
3.	Export through Local Production	--	--	2.	3.5	6.
4.	Export through Free Trade Zones	--	--	1.	2.	3.5
5.	Total Local Production	52	63	102	148	167
6.	Total Investment for Local Production	12	11	5.5	4.5	3.5
7.	FE Investment on Purchase of Foreign know-how and Capital Equipments	4.5	4.5	2.	1.5	1.
8.	FE Investment on Indigenous development of know-how and capital equipments	1	1	1.	1	1.

TABLE 2.7

INVESTMENT PATTERN FOR COMPUTER, CONTROL & INDUSTRIAL ELECTRONICS

(All figures in RS. Crores)

No.	Item	1974-75	1975-76	1976-77	1977-78	1978-79
1.	Total Local Consumption	20.5	28	38	50.5	60
2.	Total direct import of Products/ parts	6.5	8.5	7	5	5
3.	Export through Local Production	2.5	5	9	14.5	22
4.	Export through Free Trade Zones	2.5	5	9	12	17
5.	Total Local Production	16.5	24.5	40	60	77
6.	Total Investment for Local Production	7.5	7.5	4.5	2	2
7.	FE Investment on purchase of foreign know-how & capital equipments	3.	3	1.5	0.5	0.5
8.	FE investment on indigenous deve- lopment on know-how and capital equipments	60.5	0.5	0.5	0.5	0.5

TABLE 2.8

INVESTMENT PATTERN FOR COMPONENTS INDUSTRY

(All figures in Rs. Crores)

No.	Item	1974-75	1975-76	1976-77	1977-78	1978-79
1.	Total Local consumption	80	101	125	166.5	190.5
2.	Total direct import of products/ parts	15	17	11	9.5	9
3.	Export through Local production	3.5	6	9	13	18.5
4.	Export through Free Trade Zones	3.5	6	7.5	10.5	14.5
5.	Total Local production	68.5	90	123	170	200
6.	Total investment for local production	17.5	17	11	7.5	5.5
7.	FE investment on purchase of foreign know-how & capital equipments	4	7	4.5	2.6	1.5
8.	FE investment on indigenous deve- lopment of know-how & capital equipments	1	0.5	1	1	1

TABLE 2.9

INVESTMENT PATTERN FOR TOTAL TELECOMMUNICATION AND ELECTRONICS INDUSTRY

(All figures in Rs. Crores)

No.	Item	1974-75	1975-76	1976-77	1977-78	1978-79
1.	Total local consumption (Equipment)	272.4	339.15	442	577.85	647.65
2.	Total local consumption (Components)	80.0	101	125	166.5	190.5
3.	Total direct import of products/ parts	64.15	77.75	56.85	43.90	36.45
4.	Export through local production	10.75	19.10	31.85	48.55	71.30
5.	Export through free trade zones	19.20	29.20	46.60	64.10	83.20
6.	Total local production	299	381.50	543	749	873
7.	Total investment for local production	72.45	76.75	53.70	36.55	26.75
8.	FE investment on purchase of foreign know-how and capital equipments	24.20	27.45	16.35	10.85	8.25
9.	FE investment on indigenous development of know-how and capital equipments	4.10	3.70	4.15	4.15	4.20
10.	Total FE drain	92.45	108.90	77.35	58.90	40.90
	Total FE earnings	29.95	40.30	78.45	112.65	154.50

TABLE 2.10

TOTAL PROFILE: INVESTMENT AND PRODUCTION IN CIVILIAN ELECTRONICS AND COMMUNICATION

(All figures in Rs. Crores)

No.	Item	Capital Investment				Production			
		Rupees	Soft	Hard	Total	Public	Private	Plan Period	Terminal Year
1.	Consumer electronics	5.0	0.8	0.8	6.8	1.0	5.6	507	133
2.	Medical electronics	4.1	2.2	2.0	8.3	1.4	6.9	69	18
3.	Instruments	7.4	3.1	3.1	13.6	1.4	12.2	155	51
4.	Computers & calculators	11.5	2.0	12.1	25.6	12.4	13.2	186	60
5.	Control & incl. electronics	5.9	1.5	3.1	10.5	6.6	3.0	65	25
6.	Components	19.2	8.1	15.0	42.3	25.2	17.1	524	182
7.	Materials	8.3	1.7	7.3	17.3	11.0	6.3	80	32
8.	General facilities	3.7	4.1	2.2	10.0	10.0	0	10	3
9.	Telemetry & two-way communication	2.9	1.2	1.1	5.2	3.0	2.5	34	17
10.	Civil navigation	1.2	0.4	0.6	2.2	2.2	0	9	4
11.	Mass communication (I&B Ministry)	4.0	2.9	2.1	9.0	9.0	0	52	19
12.	Telecommunication (Comma. Ministry)	43.5	4.0	9.0	51.0	51.0	0	610	153
	Total	115.7	32.0	58.4	206.1	138.70	67.40	2,301	677

TABLE 2.11

DIFFERENCE PROFILE: INVESTMENT & PRODUCTION IN ELECTRONICS & COMMUNICATION

No.	Item	Capital Investment						Production		Export from Local Production	Total addl. manpower ('000)	Capital to labour radio Rs./ person
		Rupees	Soft	Hard	Total	Public	Private	Plan Period	Terminal Year			
1.	Consumer electronics	5.0	0.8	0.8	6.6	1.0	5.6	507	133	30.0	16	4000
2.	Medical electronics	3.3	1.0	1.0	6.9	--	6.9	64	18	--	17	4000
3.	Instruments	6.6	2.8	2.8	12.2	--	12.2	138	45	7.0	30	4000
4.	Computers & calculators	9.4	2.0	10.4	21.9	8.7	13.2	142	49	20.0	36	6000
5.	Control & indl. electronics	2.8	1.2	1.7	5.7	1.8	3.9	29	13	--	6	10000
6.	Components	15.3	6.7	12.6	34.6	17.5	17.1	356	127	15.0	42	8000
7.	Materials	7.3	1.2	6.8	15.3	9.0	6.3	70	27	--	15	10000
8.	General facilities	3.7	4.1	2.2	10.0	10.0	--	10	3	--	12	8000
9.	Telemetry, two-way communication	2.3	1.0	0.9	4.2	2.0	2.2	30	15	3.0	7	6000
	Total	55.7	21.6	40.0	117.4	50.0	67.4	1346	430	75.0	181	6500 (av.)

3.0 The Technology Development Programmes

It was recommended by Bhabha Committee in their Report in 1966 that "in order to develop a self-reliant and largely self-sufficient industry capable of meeting Indian needs of competing in the world market, the establishment of purposeful design and development groups is an absolute necessity. This is so vitally important a matter for the healthy development of the industry that it deserves to be examined at greater length". For advising Government of India in the implementation of the recommendations of the Bhabha Committee, an Electronics Committee was appointed under the chairmanship of Dr. Vikram A. Sarbhai in June 1966. This Committee had initiated a number of R&D programmes for rapidly expanding and diversifying the engineering and know-how bases of the industry. The growth of R&D investment in Electronics is indicated in Table 3.1. A list of R&D activities sponsored by the Electronics Committee is given in Table 3.2.

3.1 National Seminar on R&D Policy in Electronics

The Department of Electronics organized a "National Seminar on R&D Policy in Electronics" at Vigyan Bhavan, New Delhi in January 1973. The principal objectives of the Seminar were to:

- a) identify areas in the field of electronics called for intensive R&D effort, together with their inter-se priorities,
- b) recommending the basic mechanism for supporting, regulating and monitoring the R&D projects in the field of electronics,
- c) suggest measures for smooth and speedy transfer of

technology developed by the R&D organizations to production organizations.

More than 200 persons from various national laboratories, universities, R&D institutions and production units participated in the three day discussions. There were group discussions in parallel in different areas, namely, data processing systems, consumer electronics and broadcasting systems, instruments, materials, microwave components and instruments including antennas, navigational and signalling equipment, sonar and radar systems precision electromechanical components and assemblies, general passive components, and electron optics and components. Various background reports for discussions were provided by the Information, Planning and Analysis Group (IPAG) of the Electronics Commission. The Working Group identified the areas which need considerable R&D efforts and made specific recommendations regarding priorities and steps to be taken for the smooth transfer of technology from laboratories to production agencies. During the plenary session of the seminar there were extensive discussions concerned with the manner of research and development which really dovetails into the total scheme involving the growth of the industry as a whole. These discussions helped to generate a better understanding of the role of the individual sectors as well as their limitations in the overall framework.

Following the discussions at the Seminar on R&D Policy, the Electronics Commission set up a Technology Development Council (TDC) in October 1973 to assist and advise the Electronics Commission in fulfilment of its manifold tasks in the field of research and development in electronics. The Council is responsible for advising on the right type of know-how to be made available through an appropriate mix of indigenous efforts of know-how in selected fields and a coupling of imported know-how with indigenous efforts.

TDC is an advisory body. Its principal functions are to assist the Department of Electronics/Electronics Commission in:

- i) identification of areas requiring intensive R&D efforts in the field of Electronics;
- ii) assigning relative priorities;
- iii) evaluating, assigning, financing and monitoring individual R&D projects;
- iv) ensuring the transfer of know-how generated through R&D to production, and
- v) identification of areas requiring import of know-how at the R&D or production levels to conform to financial and time targets laid down for the growth of the industry.

The Council advises the Electronics Commission on the setting up of suitable management patterns, involving both R&D and production units, to achieve smooth transfer of know-how to production.

The following six expert Working Groups, each under the Chairmanship of a member of the TDC, and consisting of members drawn from national/defence laboratories, research and educational institutions, public sector undertakings and Government departments etc. have been constituted to carry out a close and detailed examination of the relevant problems in different sectors of Electronics.

Working Group I: MATERIALS AND COMPONENTS

This Working Group broadly deals with materials of all types of relevance to the field of electronics; under materials it, in particular, deals with semiconductor materials, III-V compounds, ceramics and ferrites, plastics, metals, alloys and high purity materials including gases and chemicals and devices including semiconductor devices, high power vacuum and gas-filled devices (including klystrons, TWT, carcinotrons) active and passive components etc. The group does not deal with components such as relays, connectors etc. which are essentially electro-mechanical in nature and largely based on mechanical tooling.

Working Group II: CONSUMER ELECTRONICS (to include entertainments, medical, instruments and instrumentation)

This Working Group essentially covers the field of entertainment electronics (radios, televisions, taperecorders, sound and public address systems, etc.), all medical electronics, general purpose instruments and instrumentation other than specific ones which would more naturally come in the field of industrial electronics or in the areas of microwave instrumentation or panel instrumentation.

Working Group III: COMPUTERS, CONTROL AND INDUSTRIAL ELECTRONICS

This working Group broadly covers aspects of hardware and software over the entire range of computational equipment from desk calculators to large computer systems. Specifically with the application of computer in a variety of areas of national interest. The specific area of peripherals for computers which are largely electro-mechanical in their operation are covered by Group VI. This group coordinates with Group VI to ensure that

the appropriate types and numbers of peripherals can be made in the country for the systems the group has in mind. The scope of the Working Group thus goes beyond that of just computers and covers the general area of digital electronics and signal processing techniques including control aspects; specific control devices which are largely electro-mechanical in nature are handled by Working Group VI.

Working Group IV: RADARS, SONARS AND NAVIGATIONAL AIDS

The Working Group broadly covers the totality of Radars, Sonars and Navigational aids from the viewpoint of systems design. However, it depends largely on Group I on Materials and Components from the viewpoint of high power tubes, such as klystrons and semiconductor devices, on Group III with regard to signal processing techniques, and on Group VI for requirements such as antennas, waveguides etc.

Working Group V: COMMUNICATION AND BROADCASTING

The Working Group broadly covers the area of HF, VHF, UHF, microwave communications, multiplexing, PCM techniques, all related to the field of communications. It deals with the systems concepts in communication systems as well as the needs of specific items of equipment in the area other than materials and components, and electro-mechanical devices including antenna, which come under the purview of the other Groups that have been listed. The group also covers communications in aviation, maring applications, signalling equipment including those in railways and broadcasting equipment.

Working Group VI: ELECTRO-MECHANICAL COMPONENTS AND EQUIPMENT

The Working Group essentially covers all areas where elec-

tro-mechanical devices play a role in electronics. This will include computer peripherals where the group interacts with the Group III from the viewpoint of their requirements for specifications and numbers, switching in communications systems other than electronic switching, components such as relays, connectors, antennas and waveguides which are electro-mechanical and which depend significantly on tooling, the whole area of tools and tooling needed for production of electronic components and industrial electronics of an electro-mechanical nature.

The term "Technology Development" as interpreted by the Council includes the following:

- a) Research projects that will result in substantial impact on new production during the Fifth Five-Year Plan period.
- b) Development projects posed by production organizations with strictly stipulated time and performance targets.
- c) Development projects resulting from a system engineering breakup of large equipment sought to be produced during the Fifth Plan period.
- d) Development of new process-oriented systems with strictly defined targets of productivity, performance and time, with which a production organization is explicitly identified from the beginning.
- e) Aquisition of R&D know-how on a centralized purchase basis at economically viable level of technology in the same technological branch as the

best technology in vogue having a lasting commercial promise, and superposing on this acquired know-how, the local R&D in order to bring it to contemporary levels in the shortest possible time.

- f) Development projects which will increase the productivity of existing production plants.
- g) Development projects which facilitate the duplication and improvisation of capital equipment already imported and in use in production organizations (in cases where substantial expansion of capacity is contemplated).
- h) Development projects which will lead to the custom manufacture of equipment which might be needed in small, but non-trivial, quantities.
- i) Facilities run as national or regional centres which would provide the basic infrastructure for the speedy and effective implementation of the Fifth Five-Year Plan.

Since the setting up of the TDC and the various working groups significant progress has been made. Each working group has had several meetings and have made in-depth analysis concerning projects and activities to be funded by the Electronics Commission. Technology development plan is being evolved on continual basis which has the primary motivation to maximize its impact on effective implementation of the Fifth Five-Year Plan. The working group plan includes the following objectives:

- a) Identification of high priority areas from tech-

nology as well as from requirements point of view.

- b) Identification of major gaps and actions to be taken thereof, this would include cost-benefit analysis for import substitution items, quantifications of achievement, various technological spin-offs, etc.
- c) List of the institutions which are engaged in the areas covered by the group and critical examination of their capabilities.
- d) Discussions of the institutions to be strengthened for certain specific tasks in the framework of the national objective-electronics production and services.
- e) Examining the panel reports and other documents available to the working groups.
- f) Dovetailing the plans of the Electronics Commission with those of other ministries/departments with substantial activities in electronics.

The Fifth Five-Year Plan for R&D in electronics which has been approved by the Planning Commission, envisages an investment of Rs. 20 crores for R&D projects to be directly funded by the Department of Electronics. Adapting a planned approach with the assistance of TDC as enunciated above, the Department has been implementing its R&D plan. The various projects initiated and funded by the Department of Electronics is given in Table 3.3. Several of the projects that have been funded by the Department which are completed or nearing completion have already made a significant impact on the growth of technology in the country; these are listed in Table 3.4 The project on X-band TR cells at TIFR

has culminated in regular batch production of these devices which are being successfully used in strategic equipment. The technology thus developed has paved way for the indigenous development and production of TR cells in other frequency bands and a host of other vacuum based and gas filled electron devices and affords a large reduction on the FE drain that is being incurred on these items. The project on TV camera lens has been successfully completed and is at the stage of being transferred to an industry for commercial production. Most of the projects funded to ECIL have already culminated in regular production. These include medical electronic instruments, software development, antenna for community TV receivers, front end converters for direct reception from satellites, solid state oscilloscopes, tantalum electrolytic capacitors etc. The projects on computer peripherals have led to successful indigenous development of paper tape punches, tape readers, line printers, card readers etc., and has been successful in establishing a sound base for the development and production of precision electromechanical equipment and components. The ongoing projects identified and funded through the TDC include development of essential and technically sophisticated items like wind-finding and weather analysis radar, 4 GHz-1800 channel solid state microwave system, cockpit voice recorder, materials for magnetic tapes, special purpose electron tubes, liquid crystal materials and display devices, high frequency real time oscilloscopes, automatic test equipment, eighteen column printer, thyristor controlled power drives, mining electronic equipment and a host of critical components and raw materials needed by the electronics industry.

The projects are being rigorously monitored both from technical and financial angles by a dedicated group within the structure of the Electronics Commission/Department of Electronics and with the assistance of experts in the concerned fields. The

Technology Development and Implementation Division (TDID) of the Information, Planning and Analysis Group (IPAG), Electronics Commission has been entrusted with the major tasks in this context. The Department has been paying particular attention for the maximal utilization of existing infrastructure and minimization of FE requirements for each of the projects.

3.2 Mechanism for Transfer of Technology

As regards development of technology, structure of DE/EC is such that it judiciously initiates projects at different places (under various Ministries) based on national priority, monitors them and has the responsibility for producing them for the overall growth of electronics industry. TDC under Electronics Commission integrates the chain of activities right from the inception of a technology development project to its eventual production establishment. It has a built-in technical infrastructure to handle all problems associated with know-how transfer through Electronics Trade and Technology Development Corporation (ETTDC).

For all the projects funded by the Electronics Commission, ETTDC, as an executive body of TDC, would handle all the work related to the transfer of technology.

A step-by-step approach for effecting technology transfer has been proposed as under:

1. ETTDC would work with the Technology Development and Implementation Division (TDID) of IPAG for monitoring TDC projects already underway. Using the services of technical personnel in the Department of Electronics and IPAG, as also outside consultants if necessary, ETTDC would conduct periodical techno-commercial evaluations of product-oriented TDC projects.

2. In order to meet the objectives of the TDC as outlined in the previous sections, all the Technology Development projects initiated by the TDC relevant in the present context can be grouped into the following categories:

- a) Project initiated at the in-house R&D division of a public sector production unit with definite production unit with a definite production programme in view to meet specific needs.
- b) Project aimed at import substitution of a high-technology low-volume strategic item initiated at a laboratory where the demand in the near future can be met by continuous batch production run at the laboratory.
- c) Project initiated at a laboratory with a definite tie-up with any appropriate public sector production unit for its productionization for the reasons of it being covered under Industrial Policy Resolution (IPR), strategic item, high technology item etc.
- d) Project initiated at a laboratory where the production organization is not identified.

The Technology Development projects initiated in cases a) and b) would **incorporate** by its very nature, aspects associated with the transformation of laboratory know-how to production-worthy know-how.

In case c), the production agency to take up the productionization of the laboratory know-how is identified right in the beginning. Thus, by the mutual interaction between the R&D unit

and the production unit, all the problems related with the conversion of laboratory know-how to productionworthy know-how, can be ironed out all along. In this case, if required, a pilot plant for furthering productionworthiness of the know-how could be set up in the production unit with active participation of the R&D laboratory. Services of ETTDC in the nature of technical, commercial, financial participation could be availed wherever necessary to reduce the time required for converting laboratory model to production prototype. Decision on this, could be taken on a case-by-case basis

Case d) deals with the technology development projects initiated at laboratories for which the production agencies for productionization of the resulting laboratory know-how are not identified. The conversion of laboratory know-how to productionworthy know-how could be achieved by setting up a pilot plant at a place most suited for, with the financial and technical participation of ETTDC or any other agency under Department of Electronics. For cases c) and d), when the R&D project initiated at the laboratory is complete, based on a preliminary evaluation report submitted by ETTDC and TDID, TDC would issue a certificate that the know-how developed in the laboratory is fit for transfer to pilot plant for the generation of productionworthy know-how.

3. Normally at the point of time at which the Project Executive Organization (including pilot plant stage) feels that a technology development project involving product/process development is "completed", ETTDC and TDID would prepare a techno-commercial evaluation report which would assess as to whether the product/process concerned is fit for transfer to production. Aided by this report, TDC or a technical committee set up by the TDC will examine the productionworthiness of the product and upon satisfaction to its performance

characteristics will recommend for the issue of a "certificate for eligibility of transfer to production" for the product/process concerned. This would apply to all the cases from a) to d) when productionworthy know-how is available.

4. For fixing the know-how payment, ETTDC and TDID would provide technical and commercial inputs to a sub-committee appointed by TDC for this purpose. Based on the recommendations of this sub-committee, TDC would arrive at the quantum and composition of the know-how payment involved in each case. For the TDC projects, it is desirable that payments should be in lump sum to be payable in a phased manner as decided by TDC. All the know-how fee will be payable to ETTDC.
5. For the technology development projects which may be required to be licensed to multiple parties (public/private) for production, the identification of prospective production agencies would be done by adopting several measures. First, ETTDC would contact such parties who may already be working in allied areas to assess the receptivity of these manufacturers to the new product. Simultaneously, the product would be publicized through journals such as "Electronics Information and Planning" and "Indian Trade Journal" for the benefit of all manufacturers. Based on the response from prospective manufacturers, acquired through these methods, ETTDC would prepare a list of interested manufacturers.

TDC would select from this list the most appropriate manufacturers for the issue of Letter of intent and subsequent licensing. This decision would be taken based on the prevailing industrial licensing policy guidelines. Recommendations for multiple party licensing would be considered keeping

in view the existing licensed capacity, demand, export angle etc.

6. A contract stipulating the terms and conditions and agreements would be signed between the Department of Electronics/ETTDC and the parties licensed for production (licensees). Any disagreement among the parties entering into the contract will be looked into by a committee appointed by the TDC. Based on the findings of this committee, the Chairman of TDC will take a decision on this aspect which will be final.

3.3 Funding Procedures for Technology Development Projects

On the recommendation of the TDC, the Electronics Commission had set up a panel on guidelines for evolving funding procedures for R&D projects to be funded by the Electronics Commission so as to ensure a smooth processing of the projects proposals. The following were the terms of reference of the above panel:

1. To specify proforma for each distinct type for minimum information that the organization submitting the proposal should furnish so as to facilitate all Government departments (Department of Electronics/Electronics Commission, Ministry of Finance, DGTD, etc.) involved to take decisions without a reference back to the proposer.
2. To evolve procedures for processing the applications so as to minimize delay in processing with due regard to the rules and regulations of the Government and constitutional provisions of the Electronics Commission.
3. To formulate the terms and conditions under which the financial assistance should be given.

4. To outline the optimal pattern of interaction between the recipient organizations, IPAG, Department of Electronics, TDC, departments in Finance Ministry, DGTD and others concerned.
5. To indicate the mode of funding of the expenditure incurred for TDC functioning, project identification, other pre-award activities and project monitoring on a standing basis subsequent to the award of the funds for the project.
6. To provide norms for the preparation of annual R&D budget.
7. To offer any other suggestions concerning the speedy implementation of the technology development projects.

The performance evolved by the panel for submitting project proposals to the Electronics Commission is given in Table 3.5.

TABLE 3.1

GROWTH OF R&D INVESTMENT IN ELECTRONICS
(In Rs. Crores)

	<u>1970-71</u>	<u>1971-72</u>	<u>1972-73</u>	<u>1973-74</u>
Public Sector Units	1.85	2.26	3.21	4.37
Private Sector Units	0.88	1.09	1.38	1.94
C.S.I.R. Laboratories	1.30	1.35	1.35	1.40
Laboratories associated with Government Departments such as P&T, Railways, Defence, Atomic Energy, Space etc.	6.70	7.65	8.55	1.40
Department of Electronics*	3.49	0.99	1.19	3.00
Total	14.22	13.34	15.67	19.81

* Department of Electronics supports R&D activities in different organizations, CSIR laboratories, Public Sector Units, Defence Laboratories, Educational Institutions etc.

TABLE 3.2

LIST OF PROJECTS FINANCED BY ELECTRONICS
COMMITTEE/COMMISSION BEFORE TDC WAS CONSTITUTED

<u>Sl. No.</u>	<u>Project Title</u>	<u>Implementing Organization</u>
1.	Antenna for community receiver for Satellite Broadcast Reception	ECIL, Hyderabad
2.	Solid State front end converter for community TV receiver for Satellite Broadcast Reception	"
3.	Solid State black and white CCIR standard community TV broadcast signals	"
4.	Solid State dual channel electromiograph for diagnostic applications	"
5.	Transistorized 8-channel electroencephalograph for neurological diagnostic studies	"
6.	Solid State 100 MHz oscilloscope on plug-in-concept	"
7.	Solid State variable persistence storage oscilloscope with MHz dual trace plug-in-unit normal time base plug-in-unit	"
8.	Development of CPU systems and software packages	"
	a) Exploitation of full potential of TDC-12	
	b) Development of 32 BIF computer	
	c) Software development	
9.	Project on evaluation of computer peripherals.	"
10.	Development of non-polar type solid electrolytic tantalum hard capacitors for use in serve systems	"
11.	Production of Rectilinear trim pots (both wirewound and cermet)	"

TABLE 3.2 continued

<u>Sl. No.</u>	<u>Project Title</u>	<u>Implementing Organization</u>
12.	Pilot plant for silicon crystals	ECIL, Hyderabad
13.	Development of automatic electronic (switch) (AES) to be developed for plan AREN	TIFR, Bombay
14.	Development of S-band TR switches	TIFR, Bombay
15.	ADGES project	"
16.	Development of S-band and M-carcinotron	CEERI, Pilani
17.	Design & development of minicomputer	Jadavpur University, Calcutta
18.	Development of Time Averaging Computer	"
19.	Setting up of thick/thin film hybrid microcircuit laboratory	III, Bangalore
20.	Reliability of Evaluation Laboratory	NPL, New Delhi
21.	Development of Digital and Microwave communication equipments.	BEL, Bangalore
22.	Project on R&D activities on materials	"
23.	Development of peripheral equipment	"
24.	Project for mask design and fabrication for integrated circuits	"
25.	Development facilities for thick/thin film hybrid microcircuits and their manufacture	"
26.	Development and establishment of plant for production of TR switches in X-band	TIFR, Bombay
27.	Development of high power microwave devices (Klystrom project)	"
28.	Development of integrated circuits	CEERI, Pilani

TABLE 3.2 continued

<u>Sl. No.</u>	<u>Project Title</u>	<u>Implementing Organization</u>
29.	Investigation of weathering properties of FRP antennas	National Aero- nautical Labor- atory, Bangalore
30.	Development of TV camera lens	IIT, New Delhi now with IRDE, Dehra Dun
31.	ISIS as part of ADGES	PRL, Ahmedabad
32.	Reliability of evaluation laboratory	BARC, Bombay

TABLE 3.3
TECHNOLOGY DEVELOPMENT PROJECTS FUNDED BY
ELECTRONICS COMMISSION

<u>Sl.</u> <u>No.</u>	<u>Implementing Organization</u> <u>and Name of Project</u>	<u>Total Cost of</u> <u>The Project</u> <u>(in Rs. Lakhs)</u>
<u>Tata Institute of Fundamental Research, Bombay</u>		
1.	ADGES Project	516.66
2.	Project 1/73	58.50
3.	Klystron Project (continuance of)	6.45
4.	S-Band TR Switches	17.40
5.	Development of Solid State Microwave Mixer Diodes	6.26
6.	Development of Computer Network	133.28
7.	Development of Computer-Aided Design for Realizing LSI	11.00
<u>Electronics Corporation of India Ltd., Hyderabad</u>		
8.	Exploitation of Full Potential of TDC-12	12.38
9.	Software Development	179.75
10.	Development of 32-Bit Computer	98.50
11.	Development of Rectilinear Trim Pots	3.95
12.	Development of Solid Tantalum Capacitors	3.59
13.	Evaluation of Computer Peripherals	32.00
14.	Development of 150 MHz Solid State Oscilloscope	2.50
15.	Development of Miniature Servo Components	5.05
16.	Development of Cockpit Voice Recorder	2.58
<u>Bharat Electronics Limited, Bangalore</u>		
17.	Development Facilities for Thick/Thin Film Hybrid Microcircuits	44.12

TABLE 3.3 continued

<u>Sl. No.</u>	<u>Implementing Organization and Name of Project</u>	<u>Total Cost of The Project (in Rs. Lakhs)</u>
18.	Development of Computer Peripheral Equipment	12.00
19.	Mask Design and Fabrication of ICs	79.00
20.	Development of Automatic Test Equipment	29.05
21.	Development of Wind Finding and Weather Analysis Radar	33.395
22.	Development of 4 GHz, 1800 Channel System	---
23.	Development VOR Equipment	19.50
24.	R&D Activities on Materials	56.50
25.	Development of Digital and Microwave Communication Equipment	15.00
<u>Indian Telephone Industries Limited, Bangalore</u>		
26.	Thick and Thin Film Hybrid Microcircuits Laboratory	28.677
<u>Raman Research Institute, Bangalore</u>		
27.	Development of Liquid Crystal Display Devices	5.225
<u>Jadavpur University, Calcutta</u>		
28.	Development of Time Averaging Computer	2.36
29.	Design and Development of Mini-computer	3.53
<u>National Aeronautical Laboratory, Bangalore</u>		
30.	Feasibility Studies on the Growth of Single Crystal Sapphire Plates	1.57

TABLE 3.3 continued

<u>Sl. No.</u>	<u>Implementing Organization and Name of Project</u>	<u>Total Cost of The Project (in Rs. Lakhs)</u>
31.	Preparation and Characterization of Ferromagnetic CrO ₂ for Recording Applications	3.00
<u>Central Electronics Engineering Research Institute, Pilani</u>		
32.	Development of IC Modules	9.00
33.	Development of 400 W S-Band M-carcinotron	15.98
34.	Batch Fabrication of 200 W S-Band M-carcinotron	15.16
<u>National Physical Laboratory, New Delhi</u>		
35.	Development of Liquid Crystalline Materials & Display Devices	10.00
<u>Kerala State Electronics Development Corporation, Irivandrum</u>		
36.	Development of 18 Column Printer	8.35
<u>Indian Institute of Technology, Kanpur</u>		
37.	Development of Mischmetal Cobalt Magnet	14.31
38.	Design and Development of Special Semicon- ductor Devices and Customized ICs	15.00
<u>Indian Institute of Technology, Madras</u>		
39.	Design and Development of Printing Unit	2.50
40.	Computerized Hospital Information System	2.45

TABLE 3.3 continued

<u>Sl. No.</u>	<u>Implementing Organization and Name of Project</u>	<u>Total Cost of The Project (in Rs. Lakhs)</u>
<u>Indian Institute of Technology, Kharagpur</u>		
41.	Modular Keyboard/Cassette/CRT/Printer Terminal for On-Line Usage	3.00
42.	Development of Block Diagram Language Compiler	1.01
<u>Indian Institute of Science, Bangalore</u>		
43.	Design and Development of Demountable Electron Gun	2.89
44.	Development of Biosignal Processing Techniques and Equipment	5.175
45.	Development of Prototype Thyristor Power Electronic Controllers for Industrial Motor Drives	17.41
46.	Development of Hybrid Computer - Software	4.37
47.	Development of Picture Processing Equipment & Techniques	5.86
48.	Training Centre in Electronic Design Technology	5.00
<u>University of Bombay, Bombay</u>		
49.	Development of Suspension Medium/Binder for Gamma Ferric Oxide for Magnetic Tapes	0.50
<u>Central Scientific Instrumentation Organization, Chandigarh</u>		
50.	Development of Digital Multimeter	3.08

TABLE 3.3 continued

<u>Sl. No.</u>	<u>Implementing Organization and Name of Project</u>	<u>Total Cost of The Project (in Rs. Lakhs)</u>
<u>University of Delhi, Delhi</u>		
51.	Training of Manpower in the Field of Microwave Technology	19.52
<u>Defence Electronics Research Laboratory, Hyderabad</u>		
52.	Development of YIG tuned Devices	9.95
<u>University of Calcutta, Calcutta</u>		
53.	Development of Thyristor Chopper Controller	3.20
<u>Birla Institute of Technology, Ranchi</u>		
54.	Development of Solid State Megger with Auxilliarities for Deployment in Mines	0.68
55.	Development of Thyristor Controlled Variable Speed Induction Motor Drive	1.50
<u>Indian School of Mines, Dhanbad</u>		
56.	Design and Construction of Electromagnetic Flame Detector of Winding Ropes of Defecto- scope	1.20
<u>Central Mining Research Station, Dhanbad</u>		
57.	Design and Development of Thermo-Electric Transducers Required for Instrumentation Used in Mines	1.46

TABLE 3.3 continued

<u>Sl. No.</u>	<u>Implementing Organization and Name of Project</u>	<u>Total Cost of The Project (in Rs. Lakhs)</u>
<u>Central Electronics Limited, Delhi</u>		
58.	Development of Reactive Alumina and Fabrication Techniques for Alumina Ceramic Parts	16.10
<u>Administrative Staff College of India, Hyderabad</u>		
59.	Computer Based Information System for Health Administration	4.06

TABLE 3.4

A REPRESENTATIVE LIST OF MAJOR IMPORT SUBSTITUTION
ACTIVITIES INITIATED/COMPLETED SINCE 1971

A. Radar & Communication

- 1) Transreceiver chain for satellite earth stations proposed at Dehra Dun & Calcutta, developed at ITI, Bangalore.
- 2) Frequency Division Multiplex, PCM, ADM multiplex for defence and mobile applications.
- 3) A family of microwave LOS transreceivers (2,4,6 GHz) systems at ITI, Bangalore and MIC based 4 GHz system at BEL. 1 & 2 GHz systems at HRP, Dehra Dun.
- 4) Radars for civilian applications namely satellite tracking radar coordinated by VSSC and wind finding radar at BEL.
- 5) A variety of radars like 30 mobile radar, firecontrol radar, secondary surveillance radar, battle field surveillance radar etc., at BEL for defence services.
- 6) Navigational aids like D.M.E., VOR etc., required by DGCA are being developed at BEL.
- 7) Indigenization of sophisticated communication systems for HF, VHF, UHF, & microwave ranges.
- 8) Substitution of critical microwave components like TR cells, PIN diodes, mixer & detector diodes, circulators, isolators, front and back units, parametric amplifiers, varactor diodes, filters couplers, microwave switches etc.
- 9) Automatic electronic exchange at TRC, New Delhi
- 10) Development of microwave tubes like klystrons, magnetrons etc.

TABLE 3.4 continued

B. Industrial Electronics & Controls

- 1) Thyristor control equipment for diesel locos, completed by CEERI, Pilani & productionized by ECIL, Hyderabad.
- 2) Thyristor control and drive equipment for industrial applications.
- 3) Servo components required for superfedermaus radars.
- 4) Development of synchros, servos and gyro packages at ECIL.

C. Computers & Peripherals

- 1) Development of TDC 312, TDC-16, TDC-32 computers at ECIL.
- 2) Teleprinters, paper tape recorders & punch, console typewriters developed at BEL & HTL.
- 3) Development of line printers, card readers, magnetic tape units are underway at BEL.
- 4) Computer based systems for data communication & handling.
- 5) Computer based process control systems for control of industrial processes.
- 6) Simulators for the use of defence services.

D. Instrumentation

- 1) A series of digital instruments like frequency counters, timers, temperature indicators etc.
- 2) Development of Automatic Test Equipment for testing of transreceivers at BEL.
- 3) High frequency (150 MHz) real time oscilloscope & accessories at ECIL.

TABLE 3.4 continued

- 4) Data loggers for oceanographic & other applications at BARC.
- 5) A variety of medical electronic instruments like ECG, foetal heart monitors, etc., at CSIO, LRDE, etc.
- 6) CRT based display systems for defence applications.

E. Consumer Electronics & Mass Communication

- 1) Development of CCTV System for various applications at ECIL.
- 2) Development of professional quality audio tape recorders & play-back consoles, broadcast studio consoles and announcer consoles and a family of high quality solid state audio amplifiers at BEL.
- 3) Development of Cassette tape decks for audio range.

TABLE 3.5

PROFORMA FOR SUBMISSION OF PROJECT PROPOSAL TO TDC

Title of Project:

Nature of Project
(Check One)

1. Technology Development leading to production capability in the 5th Plan period.

☐

2. Technology Development leading to production capability after the 5th Plan period.

☐

3. Application Oriented Development with possible long range production potential.

☐

4. Non-Application Oriented R&D

☐

Chief Investigator:

Department:

Institute:

Address:

Legal Status of Institution

(Indicate if Statutory, Corporate body:
Government Department, Registered Society etc.)

Production Agency with
which link up is proposed:
(where applicable)

TABLE 3.5 continued

Brief Outline of Project
stressing specific technology
fall-outs:

Duration of Project:

Budgetary Details:

YEAR

		1st	2nd	3rd	4th	5th	total
Capital Equipment:	Rs.						
	FE.						
Consumable Stores	Rs.						
	FE.						
Duty on Imports							
Staff Salaries							
Travel	Rs.						
	FE.						
Contingencies							
Other expenditure of common nature debitable to this project.							
Total	Rs.						
	FE.						

Year-wise break down of physical
achievements (in terms of aims
and objectives)

Signature of Chief Investigator

Designation:

Date:

4.0 Promotion of Electronics Industry in the States

One of the important tasks of the Electronics Commission is to develop a full-fledged electronic industry spread over all parts of the country that will accelerate the process of capital formation of all states of the Indian Union. Electronics is an industry ideally suited to achieve the basic objective of economic growth along with other social objectives like equitable generation of sizeable employment opportunities and balanced regional development. It is a labour intensive industry with a high turnover-to-capital ratio. In many sectors of electronics, production can be set up in different parts of the country without an elaborate infrastructure. Since capital requirements are comparatively low in many facets of its productive operation, the industry affords ample scope to small and medium sized units to grow.

The Electronics Commission/Department of Electronics have been encouraging State Governments to set up Electronics Development Committees to examine and advise these Governments on the lines along which the Electronics Industry can be best developed in their respective areas. The Department of Electronics is of the view that all states in the country should not attempt to develop electronics in their areas on an identical pattern governed purely by some consumer demands. The various states have quite different features in terms of natural resources, existing and planned growth of other industries (like mining, chemical, steel, shipping, textile), availability of manpower, climatic conditions, etc. Therefore any plan for development of the electronics industry in each state must take note of these features.

In order to promote and catalyze the growth of electronics in various states, the Department of Electronics has taken up

another important programme to set up Test and Development Centres in cooperation with State Governments. Under this scheme, the Electronics Commission Department of Electronics are providing financial assistance to state governments up to Rs. 25 lakhs for each state. This assistance is meant for purchase of capital equipment, test and measuring instruments, etc. The contribution from state governments is in the form of land and buildings, and other infrastructural facilities and also operation of these Test and Development Centres.

It is expected that during the Fifth Five-Year Plan period (1974-1979), at least 12 to 15 Test and Development Centres would be set up in different states. The setting up of these Test and Development Centres is expected to give a powerful boost to the industry and inculcate a greater awareness towards quality consciousness.

In the following, a brief description of the progress of some of the State Electronic Development Corporations is given.

- a) Andhra Pradesh: The State Government has set up an Electronics Development Committee consisting of representatives of various agencies both at the state and the central levels. The Andhra Pradesh Industrial Development Corporation has been identified as the lead agency for providing facilities to new entrepreneurs, with assistance from the Andhra Pradesh Small Scale Industries Development Corporation and the Andhra Pradesh Infrastructural Corporation. A Functional Estate is being set up at Maula Ali, adjacent to the Electronics Corporation of India (ECIL), at Hyderabad. It is expected to house a number of ancillary units of ECIL. A Test and Development Centre is also being set up at Hyderabad. The State Government proposes to develop two

new growth centres, one at Visakhapatnam on the east coast, catering primarily to professional and marine equipment, and the other at Tirupati for dealing with industrial and consumer electronics to cater to the markets of Madras and Bangalore.

- b) Bihar: The Government of Bihar have evinced keen interest in the development of electronics and have constituted a separate Electronics Development Committee. The Committee has finalized the establishment of a Functional Estate at Ranchi, which will be devoted largely to industrial electronics meant for use in the large/heavy industrial complexes. Both the Birla Institute of Technology at Ranchi and the Bihar Institute of Technology at Sindhri, are assisting the State Government in identifying suitable projects and assisting entrepreneurs to set up units.
- c) Chandigarh: The Chandigarh Administration has set apart a 14 acre plot for developing a special estate devoted exclusively to Instrumentation. About 18 entrepreneurs have been selected by the Administration on the basis of invited applications and the Chandigarh Administration is providing special facilities to these entrepreneurs to go into production quickly. A Test and Development Centre will be located in the Estate.
- d) Gujarat: There are about 40 electronics industrial units in the state with a total annual turnover of about Rs. 9 crores. The major centres of electronics are Baroda and Ahmedabad. A Test and Development Centre has started operating at the Makarpura Industrial Estate in Baroda. Another Industrial Estate is proposed to be set up on a 100 acre plot near Ahmedabad. An Electronics Development

Corporation has recently been set up by the Gujarat Government. The Kandla Free Trade Zone is also being revitalized to take on new electronics units.

- e) Haryana: The Haryana State Industrial Development Corporation is currently acting as the promotional agency for stimulating the growth of electronics in that State. The State Government is proposing to set up an Electronics Functional Estate at Faridabad on a 100 acre plot to implement the letters of intent given to various parties for Television Sets, Trans-receivers, Ferrites, etc. A Test and Development Centre is also proposed to be set up at the same location.
- f) Himachal Pradesh: The Government of Himachal Pradesh has decided to set up an Electronics Estate at Solan to promote new units in electronics. A Test and Development Centre is also proposed to be set up in the Estate with assistance from the Department.
- g) Kerala: The Kerala State Electronics Development Corporation came into being about two years ago. The Corporation has undertaken production in diverse areas such as, Electrolytic Capacitors, Ceramic Capacitors, Crystals, TV receivers, Desk Calculators and industrial Speed Drives. The units to manufacture these items are being set up on a widely dispersed basis throughout Kerala. The Corporation envisages that during the Fifth Plan period, a total of Rs. 15 crores will be invested, leading to a turnover of Rs. 21 crores in the terminal year, and providing employment to about 3,500 persons. The Corporation is setting up a Test and Development Centre near Trivandrum.

- h) Maharashtra: The State Government has set up a Test and Development Centre at the Poona Engineering College Campus. A second centre (under the same scheme) is proposed to be set up at the Regional Engineering College, at Nagpur, to cater to entrepreneurs in the Vidarbha Area.
- i) Punjab: The Punjab State Industrial Development Corporation is currently implementing various letters of intent issued to them. A Television receiver manufacturing project is now in production, while in the case of Transreceivers, a pilot plant is proposed to be set up at Chandigarh with know-how from CEERI, Pilani. A Test and Development Centre is being established in the Industrial Area being developed near Chandigarh. The State Government is also contemplating setting up an Export Processing Zone.
- j) Rajasthan: Two Electronics Estates are now in operation at Jaipur and Pilani and their activities are proposed to be expanded in the near future. A Test and Development Centre is being proposed to be set up at Jaipur. The State Government proposes to set up another centre at Pilani with technical assistance from CEERI, Pilani.
- k) Tamil Nadu: There is at present no Corporation exclusively devoted to the growth of Electronics in Tamil Nadu but the State Government has under consideration a proposal to set up such a Corporation. The Small Industries Development Corporation is taking care of the financial needs of the young entrepreneurs in the State. At present there are 92 small scale units in Electronics, with 325 ancillary units exclusively catering to the needs of these units. There are also three Service Centres for Electro-medical equipment installed in the various hospitals and colleges.

The State has taken the lead in establishing the Vikram Sarabhai Industrial Estate in Electronics and Instrumentation at Adyar near Madras. At present 52 units are in operation in the estate manufacturing various items such as PCBs, Television Sets, Capacitors, Instruments, Deflection Components etc. The State Government proposes to extend this approach to build other growth centres at Madurai, Trichy and Hosur. These functional Electronics Estates are designed to accommodate feeder units and also to manufacture all hardware items so as to make the main manufacturing units economically more viable. A Functional Electronics Estate with about 20 units is also in operation at Kakkalpur near Madras. The State Government has set up a Test and Development Centre in the Adyar Estate.

1) Uttar Pradesh: The UP Electronics Corporation has started functioning from August, 1974. Its first task was to identify the problems and potentialities of the State and then evolve a strategy for development. For this purpose, a three-pronged approach has been worked out:

- i) assistance to existing entrepreneurs to help implement the letters of intent already issued to them;
- ii) creation of infrastructural facilities such as power, electricity, water, land, financial assistance procurement of raw materials and marketing;
- iii) creation of new growth centres for electronics at strategic areas within the State.

At present Kanpur, Allahabad and Rae Bareli have been identified as potential growth centres and Functional Electronics Estates are being promoted in these places. The work regarding

the estate at Kanpur is in full swing and about 70 units are being promoted on the estate. The Indian Institute of Technology, Kanpur is being actively associated with the development of these units. At Allahabad, the existing industrial estate is being utilized and the Corporation proposes to set up a manufacturing unit for TV receivers in collaboration with the Electronics Corporation of India Ltd., Hyderabad. Special efforts are being made to develop ancillaries for the central public sector undertakings at Ghaziabad (BEL), Naini (ITI) and Rae Bareli (ITI).

The Government of Uttar Pradesh has submitted to the Department a proposal for the establishment of a Test and Development Centre in the industrial estate of Panki near Kanpur. Another complex is also being assisted at Bhimtal in the Hill areas of the State.

- m) West Bengal: The Government of West Bengal has set up a separate Electronics Development Corporation. The Corporation has been issued letters of intent for a number of items like Ferrites, Calculators, Trans-receivers and TV Picture Tubes. On the last item the Corporation has established a collaboration with Bharat Electronics Ltd., Bangalore who are the major manufacturers of this item in the country. The state government has proposed a Test and Development Centre to be set up in Calcutta.

5.0 Plan Implementation Activities

As indicated in Chapter 2, a total capital investment of Rs. 206.1 crores is envisaged for the entire Electronics and Communications industry during the Fifth Five-Year Plan period (1974-79), while for the difference profile an outlay of Rs. 117.4 crores is envisaged. Out of this outlay for the difference profile, an investment of the order of Rs. 50 crores is planned for the public sector.

A list of the activities planned to be initiated under the purview of the Department of Electronics was also given in Chapter 2. During the past two years, several of these activities have already been initiated or are in advanced stages of implementation. There are:

1. Electronics Trade and Technology Development Corporation.
2. Complex for production and R&D of sophisticated semiconductor devices.
3. National Automation and Control Programme.
4. Standardization, Testing and Evaluation.
5. National Informatics Centre, Delhi.
6. National Computer Centre, Calcutta.
7. Computer Maintenance Corporation

In the following, a brief description of the status of various activities listed above is given:

1. Electronics Trade and Technology Development Corporation

The main difficulty in increasing import/export trade between India and East European Countries has been the lack of communication. The result so far has been poor implementation of

trade provisions, so far as electronics is concerned, due to insufficient information in India concerning the development in electronics in USSR and other East European Countries, details of their products, lack of updated catalogued information and language barrier.

A delegation consisting of specialists in the field of electronics visited these countries to study various aspects of trade possibilities. The delegation observed that a wide variety of items exist which are technically suitable for import from and export to the socialist countries. Towards this end extensive marketing and technical monitoring were required.

Following the recommendations of the technical delegations to USSR and East European Countries, the Electronics Commission in consultation with some other Government Departments approved the setting up of an Electronic Trade & Technology Development Corporation (ETTDC) to fully exploit the immense possibilities of mutual trade and cooperation between India and these countries.

ETTDC was incorporated in New Delhi in August 1974 as a Public Limited Company with an authorized capital of Rs. 50 lakhs. The principal objectives of the Corporation are:

- a) Techno-Commercial negotiations in foreign countries to standardize electronic items, components, materials etc., for Indian industry.
- b) Bulk imports and stock-pile of strategic items for electronics industry, internal distribution of such items.
- c) Promotion of export trade by diversification,

quality assurance, product support abroad, development of new markets, participation in fairs, exhibitions and seminars.

- d) Joint production ventures within the country or abroad for increasing exports.
- e) Assistance in exploitation of existing capacity and/or possible expansion of capacity in production units by locating additional markets for their products abroad.
- f) Locating and obtaining suitable foreign know-how for integrated development in electronics.
- g) Sale of Indian know-how abroad.
- h) Full exploitation of Inter-Governmental trade agreements in electronics.
- i) Technology Development in the electronics field for the benefit of Indian Industry.
- j) Maintenance of full and updated information on technology and development in the country and abroad.

As a result of continued efforts of ETTDC in diversifying the trade with East European countries initially, it has been able to locate various new items like computer peripherals, computer tapes and also computer systems from East European countries at competitive prices. This has resulted in savings in cost and also advantages of converting free foreign exchange

purchases to the Rupee Payment Area. ETTDC plans to do a trade volume of about Rs. 7 crores by the end of March, 1976.

On the export side, vigorous efforts are being made including launching of various export-oriented production projects with ETTDC's trade partners presently in Eastern Europe. At least 3-4 projects are likely to be finalized before this financial year, which would mean the average export production-cum-sales rate of about Rs. 3 - Rs. 4 crores in another 2-3 years' time. Progress on short-term export schemes also is likely to be significant. ETTDC has already got an export order for teleprinters, from Ceylon and it is expected to get shortly an order for stereo amplifiers from West Germany. In addition, various items for which ETTDC has quoted in Western and Eastern Europe are getting adequate response and it is hoped that by the end of this year export orders worth at least Rs. 50 lakhs will materialize in the normal course and it is likely that it may be as high as Rs. 1 crore. ETTDC plans to increase its import volume to Rs. 10 crores and exports to Rs. 2 crores in the year 1976-1977.

The Corporation is starting its foreign offices before the end of this financial year - one at Moscow and the other at Warsaw. Another important role which ETTDC is playing is to help provide the import requirements of the technology development projects sponsored by the Department of Electronics as also those of the Test and Development Centres being set up by the Department in the various States.

Various facilities are being arranged by ETTDC to help boost the production of electronics. One of these is the Industrial Raw Materials Assistance Centre, through which long-delivery and critical components will be stocked in advance by ETTDC for supply

to manufacturing units at the time need arises.

2. Complex for Production and R&D of Sophisticated Semiconductor Devices

Recognizing the importance of semiconductor devices for overall development of the electronics industry in the country, the Department of Electronics set up a "Semiconductor Committee" in 1972 to study and advise regarding the future growth of semiconductor industry in the country. The expert Panel had recommended, among other things, setting up of a Public Sector Corporation for production and R&D of sophisticated semiconductor devices. The Panel further recommended that since there is a big gap existing in the country in this area, the technology should be purchased from suitable overseas vendors to cut short lead time. While accepting the proposal for setting up this facility, the Electronics Commission decided that since financial requirements were quite large (of the order of Rs. 12 crores) the proposal should be examined in greater detail and a feasibility report should be prepared. In order to locate suitable vendors abroad, an expert delegation visited some units overseas.

The Electronics Commission has since accepted the feasibility report and has finally approved setting up of the corporation. Steps are underway to establish the corporation. The product-mix consists of MOS/LSI devices, LEDs, Packages of LSIs etc. The plant also envisages manufacture of bipolar LSI devices, and packages at a later stage. The facility, when completed, will be fully integrated. It will produce its own single crystal silicon and also synthesize gallium arsenide phosphide. It will have capability of mask making computer aided design, and ion implantation. When fully operational, the plant will have about 550 direct workers and an equal number of indirect staff. It is likely

to produce 1.5 million MOS LSI, 1.4 million LEDs, 7,000 microwave devices, resulting in a total sales turnover of Rs. 14 crores.

Keeping in view the importance of substantial research and development inputs for proper growth of the semiconductor industry, a separate organization is to be set up wholly devoted semiconductor research and development as a part of the larger semiconductor complex.

3. National Automation and Control Programme (NACP)

Automation and control technology is one of the mainsprings of any economy and has led to an unprecedented increase of productivity of labour.

National Automation and Control Programme (NACP) was proposed by the Department of Electronics as an important activity during the Fifth Plan period. The main aim of the programme is to promote the right kind of automation activities in the country and nucleate the efforts in some of the high priority areas of national importance.

The activities under NACP were initiated in September 1975. An advisory board for NACP has been formed consisting of experts from the field of Automation, Control and Instrumentation. In view of the complexity that is invariably associated with the control and instrumentation tasks that arise in the context of large and medium scale industrial plants, an integrated and methodical approach towards the system design becomes imperative. Systems engineering embodying a whole variety of concepts and techniques drawn from several engineering disciplines provide a rational approach for developing productive-automation systems.

The broad categories of tasks involved include control system design, hardware selection, system integration, commissioning and testing. The systems engineering approach is being developed as a discipline for the integrated development of the field of control and instrumentation. The work has started on the design of a few critical subsystems relating to the development of digital control technology. The work is in the advanced stages for the development of certain high priority items for agriculture which are of high relevance from the overall national perspective.

Technology Development Council (TDC) of the Electronics Commission provides financial support for the various research and development activities in the field of electronics. The working group of the TDC has evaluated a few proposals in the field of mining electronics, industrial electronics and control, and are being funded by the Department of Electronics.

Keeping in view a new range of application of electronics in areas such as agriculture, flood control, pollution control, shipping, textile, jute, etc., special systems development activities have been launched under NACP. In order to cater to a wide variety of disciplines, a centralized information system is proposed to be set up to provide data on production status, type of R&D carried out in the country etc.

4. Standardization, Testing and Evaluation

Standardization activities in other countries closely followed industrial development while in India standardization was necessary as a preamble to our industrial growth for providing direction, control and guidance.

Standardization and its implementation envisages four basic activities, namely:

1. Research in environmental and life testing, failure modelling, reliability prediction etc.
2. Preparation of standards.
3. Testing to standards and preparation of Test Reports.
4. Certification based on the Test Reports.

Preparation of one unified series of standards will minimize the diversity of items to be produced and optimize the scale of production. Progress of standardization is not possible without a scheme for unified inspection and testing. The testing of materials, components and equipments to the standards requires a provision of elaborate and detailed test facilities. It may not be possible for all the production units, particularly in the small scale sector, to own such a facility for themselves. Therefore, it was recommended by the Bhabha Committee that test facilities be set up in various industrial centres such as Bangalore, Bombay, Calcutta and Delhi, in which the electronics industry is established.

Efforts are underway to augment the facilities at NPL and National Test House etc. to cater to the standardization requirements of the electronics industry.

In pursuance of the recommendations made by the Bhabha Committee, Bhabha Atomic Research Centre was advised to set up Reliability Evaluation Laboratory and National Physical Lab-

oratory and the National Physical Laboratory was advised to enhance its test facilities and to establish a Test and Evaluation Centre. Similarly the facilities at Controllerate of Inspection Electronics were made available to the industry by the Ministry of Defence. The National Test House, Calcutta also started its electronics division with this objective.

To examine the extent of addition in facilities required for calibration, testing, etc., the Chairman of the Electronics Commission has already set up a Panel which is evolving guidelines for funding in this area.

The Panel has recommended the following fields of activity in respect to electronic equipment, components and materials:

- i) Equipment: It is necessary for assuring the quality and reliability and for improving the maintainability of all electronic equipment, that standard components should be used to the maximum extent. However, as regards the standardization of equipment themselves, the agencies concerned can examine the details as to what extent it can be achieved.
- ii) Components: There is an urgent need for standardization in the field of components to provide guidance to the industry in the production of components and to the equipment designers in the choice of components.
- iii) Materials: For indigenous development and production of electronic grade materials, it is essential to draw up specifications/standards for

these materials on the same lines as for the components.

5. National Information Centre, Delhi

With a view to exploit the development catalyzing applications of computers in different regions, it was decided upon the establishment of national computer facilities by installation of large computer systems in different regions, namely Bombay, Delhi, Bangalore, and Calcutta.

The concept of such national computer centres is aimed at:

- i) Provision of a facility which would act as an impetus to the growth of decision and planning automation in the region and which in turn accelerate the pace of social and economic development.
- ii) Provision of a facility which would make available in a centralized location, data and information banks in mutually correlated disciplines or technologies and which in turn would make possible analysis and planning on an integrated basis and the application of such information in the implementation of specific development activities.
- iii) Encouraging region-wise centralization of scientific and industrial information which would also facilitate inter-regional exchange of information.
- iv) Encouraging the growth of technologies which are

vital for economic leap-frogging but which involve design sophistications requiring extensive computer-aided optimization; and

- v) Provision of a facility which would make available training expertise in advanced computer software development to meet the growing system and application of software demand in the country.

To undertake these classes of problems large computer facilities are essential. But for a developing country to acquire a large computer costing one to five million dollars is itself a major project. So, the Government of India have proposed the setting up of three major computer centres at Bombay, Delhi and Bangalore under the UNDP country programme (India).

The National Informatics Centre at Delhi was conceived to bridge the gap in the information bases for national planning in areas which cut across the responsibilities of several Ministries/Departments of the Government of India.

A crucial requirement for national socio-economic planning and planned management is the availability of an extensive information system based on reliable data. Only then does it become possible to develop and to analyze policy options by employing, modelling and forecasting techniques.

The Government has therefore, decided to improve and develop national information systems and to create the information handling tools (software and computer techniques) necessary for this purpose.

It is recognized that this project is of very great national importance and the Government has therefore, decided to secure international technical and financial support for the project

through the UNDP. Although many of the tasks listed in the project programme have already been developed to some extent in countries with a tradition of longer and more extensive computer utilization, it may be emphasized that the scale and complexity of this project makes it a pioneering experiment. The successful implementation of this project will provide experience that may be used to advantage in a number of developing countries. From the standpoint of priority, three data banks which have a pronounced influence on the national economy have been identified and are proposed to be taken up for implementation as the first step. These are, an Agricultural Information System, Manpower Information System and Science and Technology Information System.

6. National Computer Centre at Calcutta

The centre at Calcutta, which will be housed at Jadavpur University, is being financed by the Electronics Commission for acquiring computer hardware. This computer centre is proposed to be commissioned by the beginning of 1976 and is expected to meet the computational needs of the Eastern Region.

The Eastern Region with a large number of scientific research organizations like Jadavpur University, Indian Statistical Institute, Saha Institute of Nuclear Physics, Indian Institute of Technology (Kharagpur), Indian Institute of Management, Indian Association for the Cultivation of Science, Central Engineering and Design Bureau, VEC Project (DAE) etc., and business houses like Tata Iron and Steel, The Indian Iron and Steel, Heavy Engineering Corporation, Indian Explosives, Hindustan Shipyard, Tata Engineering and Locomotive etc., has a high potential demand for computer time. The computer usage in the region has developed very widely particularly in the scientific and educational sectors. A large number of users are currently handicapped for want of

suitable computer facilities and have to run to Bombay, Delhi and Kanpur. In the commercial area, systems currently installed are generally loaded to near optimum.

The computer facility to be established in the Eastern Region will primarily meet the computational loads in Calcutta city, Kharagpur, Ranchi and other parts of the West Bengal, the requirements of Bihar, Orissa Eastern UP and part of Andhra Pradesh.

The major user of this regional centre would be the Jadavpur University who have at present no significant facilities to support their capabilities in computer hardware and software design. The University has designed and built the computer ISI-JU-1 in 1961 in collaboration with ISI. Apart from the ISIJU, the University has also an IBM 1130 on hire at present. The University has a good infrastructure in terms of trained manpower in order to run a large regional centre. The University has 10 engineering departments, with about 400 members on the teaching staff. The University has an intensive computer science programme in its Department of Electronics and Telecommunication Engineering. This department has been actively associated on computer projects with agencies such as BEL, ECIL and SINP. This department has currently undertaken two projects, one for the development of mini-computers and the other for the development of a Time Averaging Computer for signal to noise ratio enhancement, which has applications in various fields, e.g., in Nuclear Magnetic experiments.

7. Computer Maintenance Corporation

Computers have been in use in India for over a decade now and today the number of installations is well over 230 machines.

The major portion of these is still of foreign origin as only about 30% account for indigenous machines. The maintenance of these machines of foreign origin has been mainly in the hands of foreign companies since a large percentage of these machines are on hire or have a maintenance agreement between the user and the supplier.

The large amount of money which goes in for the maintenance of these computers and the fact that there is a heavy dependence on the suppliers of the above machine in such a vital field as computers were the reasons for setting up a centralized computer maintenance corporation.

Computer Maintenance Corporation (CMC), a public sector undertaking, has been set up to fulfill the following main objectives:

- a) Plan, coordinate and implement the national effort on maintenance and gearing up of indigenous capabilities to ensure a high degree of availability of computers, information processing machinery and related equipment of optimum efficiency.
- b) Carry out research and development on computer and allied equipment maintenance management and apply statistical and operations research techniques to optimize maintenance procedures and stocking patterns of spares to suit Indian environments.
- c) Render consultancy services on hardware selection, installation, maintenance and other allied activities for computer systems to users and manufacturers on an as required of turn-key basis.

- d) Conduct training on all aspects of computer and allied equipment maintenance and coordinating the training facilities already available in the national laboratories and educational institutions so as to achieve optimum availability of computers and to keep abreast with the state of the art.
- e) Process procurement and holding of computer and allied equipment maintenance spares and materials etc.
- f) Plan and system-engineer data-communication and terminal equipment and any other related requirements ensuring necessary liaison with the Ministry of Communications.
- g) Maintain continuing technical and commercial contact with organizations both at home and abroad, so as to identify/locate/modify/standardize etc; components, materials and equipment relating to computer maintenance for use in India on satisfactory commercial terms.
- h) Provide support on systems and diagnostic software development.
- i) Acquire and take over, when so instructed, the computer and allied equipment maintenance units /establishments of the Government and selected Public Sector Autonomous Units, together with all their rights and liabilities.

The Corporation would have its Head Office located in

Hyderabad and branches at New Delhi and Bombay initially and Madras and Calcutta later.

6.0 Current Status of the Indian Electronics Industry
- A Profile

The electronics industry in India, today is poised for rapid growth. It is increasingly playing an important role in the national development. Starting with the manufacture of radio receivers by a few private firms in the early 1950's, the industry has not only grown in total volume but also has diversified enormously over the last 25 years. In fact there is hardly any major sector of economy in which electronics does not find some use. The recent trends have been towards growth of professional electronics and self-reliance in many of the high technology areas, the pace for which has been set by the rapid growth of the consumer electronics sector since the submission of Bhabha Committee report.

A survey of the national developments in the country indicates the vital role played by the electronics industry. More than 85% of India's population is now covered by the mass communication media like radio and television. The defence preparedness is now being based more and more on the indigenously manufactured equipment and systems. The process control instrumentation is being increasingly used for optimizing the out-puts of various process and manufacturing industries, like fertilizers, petrochemicals etc. Indigenously produced computers are being used in some cases. In the bid to become self-sufficient in power requirements India has embarked on major developments in the areas of nuclear and other power sources. Electronics plays a pivotal role in the control of nuclear reactors and optimal distribution of power through the grids. The launching of the first Indian Satellite is testimony of the excellence in the ability to design and implement complex projects involving myriad of electronic systems. The SITE programme has played a

significant role in the education of rural masses.

The present section briefly reviews the present status of the Indian Electronics Industry. It should however be noted that this does not aim at a comprehensive coverage of the entire electronics industry and only some important aspects are presented.

6.1 Growth of Electronics during the last Decade

The era of rapid development of the electronics industry may be traced to the establishment of the electronics committee by the Government of India under the chairmanship of the late Dr. Homi J. Bhabha. The report of the Bhabha Committee which was submitted in 1966 brought forth the need for intensified growth of this industry along predominantly indigenous lines. The report which has, for the first time, quantified the status of the electronics industry and the needs for the decade 1969-1975, has presented a master plan for the development of this key sector. It estimated that the annual capacity that has to be reached by 1975 would be around Rs. 300 crores in the pessimistic limit and Rs. 500 crores in the optimistic limit. Since the time of Bhabha Committee the consumer electronics sector has grown at more than twice the rate suggested by the report. However, the growth rate of the professional electronics area was much slower than the suggested one. A total investment of Rs. 170 crores was envisaged for the electronics industry during the ten year period 1965-1975.

During the last ten years the production of electronic equipment and components has increased very significantly. A profile of the growth production in the electronics industry during the decade 1965-1975 is given in Table 6.1. The developments since the publication of the Bhabha Committee report were reviewed at the National Conference on Electronics in early 1970. The con-

ference brought together planners, manufacturers and users to discuss different aspects of the industry. After assessing the progress, the recommendations of the conference emphasized that it is imperative to set up a separate organization to review the entire field of electronics in view of the fast changing technology and recommend ways for achieving self-sufficiency in the shortest possible time and the best possible manner.

During the past decade the industry has been growing steadily and over the past five years the industry has grown at an average annual rate of over 20%. During this period the consumer electronics sector experienced a geometric growth rate whereas the professional electronics industry followed the linear growth pattern. The last decade also saw the emergence of the small scale sector in a big way and many of them have been started by technical entrepreneurs. The commercial viability of the small scale units has been amply demonstrated by the high quality consumer electronic items, test and measuring instruments, medical electronic equipment etc. in this sector. A main thrust behind country's self-reliance and self-sufficiency in the consumer items have been from the well established base in the organized private sector and the small scale manufacturers. The private sector is also responsible for substantial export of electronic items. This sector besides, pioneering in desk calculators, has also entered into areas like radio frequency cables, microwave components, digital instruments, control equipment etc.

6.2 The Role of Public Sector Undertakings

Electronics is one industry in which the Indian public sector has continued to play a vital role. There are public sector units which produce sophisticated defence equipment like communication systems and radars, and those which also produce

consumer electronic equipment like television. There has been keen competition between different units and also with the private sector units. In some public sector units a large part of the manufacturing know-how has been obtained from foreign sources to minimize the time frame for the production of strategically important items. In a few others the production is totally based on indigenous know-how. In any case all the units have now established the research and development departments for product diversification and import substitution activities.

There are totally nine public sector undertakings operating in the field of electronics. The pioneer is the Indian Telephone Industries (ITI) established in 1948 at Bangalore. It operates under the Ministry of Communications and is responsible for producing a wide variety of telecommunication equipment. Apart from its major complex at Bangalore, a new long distance transmission equipment factory and a new telephone instrument factory was set up at Naini. A second switching factory has been commissioned at Rae Bareilly. ITI is setting up another unit at Palghat for the production of electronic exchanges.

The Bharat Electronics Limited (BEL) was set up in Bangalore in 1950 under the Ministry of Defence. BEL manufactures professional electronic equipment consisting of various types of transmitters, receivers, radars, etc. It also produces several types of electronic components such as receiving and transmitting valves, semiconductor devices, integrated circuits, crystals etc., and has been exporting sizeable quantities to developed countries. BEL also produces TV picture tubes. The second unit of BEL at Ghaziabad manufactures, microwave and radar equipment.

The Hindustan Teleprinters Ltd. (HTL) was set up in Madras in 1969 to manufacture teleprinters and it now completely caters

to the demand of telegraph service in the country. The factory has an annual capacity to manufacture 5000 teleprinter units per shift of operation. HTL has already entered the export markets with specially designed arabic teleprinter model for the middle-east countries. HTL has started development of many different types of computer peripherals which would be productionized soon.

The Electronics Corporation of India Limited (ECIL) was set up in 1967 at Hyderabad under the Department of Atomic Energy. ECIL is characterized by its commitment to growth on an increasingly local research and development infrastructure. The growth of ECIL has been one of the fastest in the electronics industry and its production has been practically doubling every year since its inception. The important divisions of ECIL are Nuclear Instruments Division, Resistors and Capacitors Division, Servocontrols Division, Power Reactor Division, Semiconductors Division, Computer Division, Television Division and Microwave Division.

The Instrumentation Limited (IL) was set up in Kota in 1968. The main product line of IL is process control instruments and it has specialized in control systems for power units. It has won export orders for different types of instruments as well as turnkey projects. IL plans to diversify its product range and will be entering into the manufacturing of pollution monitoring instruments and gas analyzers. IL has set up a second factory at Palghat for the manufacture of control valves.

The division of Hindustan Aeronautics Limited (HAL) at Hyderabad under the Ministry of Defence was primarily set up to manufacture electronic equipment for different aircrafts. The product line includes components, airborne equipment, approach radars, IFF and UHF equipment among others.

The Hindustan Cables Ltd. (HCL) at Roopnarayanpur and Hyderabad is engaged in the manufacture of telephone cables and related items.

Among the recently established public sector units are Central Electronics Limited (CEL) and Electronics Trade and Technology Development Corporation (ETTDC). CEL is under the Department of Science and Technology and was set up in 1974 with the aim to productionize many of the items developed at the National Laboratories. The product range includes professional grade ferrites and ferrite components, ceramics and ceramic based components, liquid crystal displays, etc.

ETTDC operating under the Department of Electronics was set up in 1974 with the main aim of increasing the trade in electronics with other countries. It is expected to help procure the raw materials and know-how for small entrepreneurs, avoiding the delays.

The discussion on public sector units in electronics will not be complete without the mention of newly started State Electronics Development Corporations. The first of these was set up in Kerala, two years ago and has already started manufacturing several items. Functional electronics estates have also been set up in Tamil Nadu, Maharashtra and Uttar Pradesh. Gujarat, West Bengal and Uttar Pradesh have set up the State Electronic Development Corporations. Setting up of these corporations is expected to evenly distribute the industry throughout the country. Department of Electronics has already started the implementation of the plan to set up Test and Development Centres at the major centres of electronics in the country.

6.3 Growth of Different Sectors of Electronics

The growth and status of the Electronics Industry may perhaps be best described on the basis of various well established sectors like consumer electronics, mass communication, telecommunication, computers, controls, industrial electronics etc. In the following the salient features and the present status of the important sectors are briefly described.

1. Consumer Electronics:

The main items falling in this category are Radio, TV, Tape Recorders, Record Players, and Public Address Systems. The radio industry is the most important in terms of production. Although, the production of Radio Receivers had begun in the country soon after independence, the real spurt in the growth of the industry began in the late-fifties after the introduction of the Transistorized Radio Receivers. The "Transistor Revolution" brought the Radio in a big way into the countryside and coupled with the expansion of All India Radio in the Second Five-Year Plan period, there was a rapid increase in the licenses for radio receivers ever since; from a figure of 11.76 lakhs in 1956 the licenses for radio receivers has gone up to 140 lakhs in 1973. The main factors for this increase in demand are the rise in the standard of living of the common people, the growth of broadcast services in the rural areas, increased electrification programmes of the rural and semi-urban areas, introduction of diversified programmes of All India Radio as well as the availability of transistorized radio sets at a price which is within the reach of a large cross section of the society. The production of radios during the last fifteen years both in the organized and the small scale sector is given in the following table 6.2.

It may be seen from the above, that there has been a rapid growth both in the organized and the small scale sector up to 1970. Subsequently, there has been some slowing down in the demand of the radio receivers. The reason for this decline has been analyzed both by Government agencies as well as the concerned associations of industry and trade. Broadly, it would seem that this decline is due to the following factors: there has been a change in the purchasing power of the people due to the rising cost of living, the total coverage of the country by the broadcast transmissions of All India Radio is yet to be attained. In spite of the above factors, it is felt that the rural market offers large potential for the growth of sales of radio receivers. The Department of Electronics had proposed to the Planning Commission a Pilot Project for studying the potential of the rural market and the techniques to fulfill the demand at a minimal cost. It is, however, believed that there is still a significant possibility for enterprising entrepreneurs, both in the small and medium sectors, to organize a methodical campaign to reach the rural areas. The question of increasing the coverage of the Vividh Bharati programmes by putting them out on the high power transmitters has also been taken up with All India Radio. A pioneering role has been played by small scale units in reducing the price of radio receivers. It is, in fact, the small scale sector that has been largely responsible for the introduction of the low cost transistorized sets and has contributed greatly towards bringing down the price of the medium band set. In recognition of this effort, special facilities have been provided to the small scale sector to compete on equal terms with the large scale units. The excise duty on radio receiver sets costing below Rs. 165/ manufactured in the small scale sector is completely waived. In addition, the Department of Electronics is providing grants up to Rs. 25 lakhs to State Governments for the setting up of Testing and Development Centres at various loca-

tions in order to help small scale manufacturers for producing uniformly good quality of radio receivers. Export of radio receivers is being done both by the organized as well as the small scale sector to the Middle East and African countries as well as Western Europe. The present level of export of radios is about Rs. 2 crores per year and a significant proportion of these exports is from the small scale sector.

The television industry is relatively new in the country. The production of TV receivers had commenced in 1970 with two firms in the organized sector and two small scale units. The Electronics Commission which was set up in 1971 decided that there is a distinct need for the creation of more capacities to cater to the increased demand of TV sets, consequent on the opening of new stations in the country in the Fourth Plan period. For the creation of capacity, the following guidelines were laid down by the Commission. i) There is no need for any foreign collaboration or know-how for the manufacture of TV sets. ii) No TV sets with foreign brand names should be allowed to be manufactured and no licenses need be given to companies with foreign equity holding. iii) Fifty per cent or more of the total capacity should be licensed to units in the small scale sector and preference would be given to qualified engineers/scientists and consortia of small scale units. In accordance with these guidelines, licenses were issued in the organized sector primarily to public sector agencies such as the State Industrial Development Corporation. In the small scale sector, 59 units have been approved largely for technically oriented entrepreneurs and those who have had experience in the radio industry. The Department of Electronics has rendered promotional assistance to the TV manufacturers particularly those in the small scale sector, through formulation of a uniform list of capital equipment to be imported, arrangement for suitable credits for this purpose, liberalization of the rules by which raw material and components are allowed to

new units and allocation of suitable foreign exchange for the import of raw materials.

The Department has been consistently encouraging the indigenous production of components for the TV receivers. In view of the rising costs of the glass bulb and the foreign exchange expenditure likely to be incurred during the Fifth Plan period, the Department of Electronics has been actively considering the question of setting up a public sector undertaking for the production of glass bulbs in the country. Since July, 1974 the grant of new capacities for TV manufacture has been restricted in view of the sufficient number that had already been approved to meet the estimated demand.

There has also been substantial increase in the production of cassette tape recorders and amplifier systems. Continuous attempts are being made to increase the indigenous content of these items. There was considerable growth in the export of PA systems and stereo amplifiers over the last three years.

2. Mass Communication:

This sector is mainly concerned with the radio and television broadcasting. Different types of broadcasting hardware is manufactured in the country. These include medium and high power medium wave transmitters and studio equipment at BEL, Bangalore. Several types of transmitting tubes are also manufactured in the country. The development work on microwave links is underway. A link has been set up between Bombay and Poona for the TV transmission. The work on broadcasts through satellites is underway at OCS and ISRO. AIR has also produced a few low power FM transmitters for utilization in its network as studio-transmitter links. The future demand for mass communication equipment is governed by

the plans of All India Radio and the finances available for its expansion.

An important step in the mass communication field in India is setting up of the Satellite Instructional Television Experiment (SITE) particularly for rural areas. The experiment started this year and will continue for a year. The important achievement is the establishment of the entire ground segment by the indigenous hardware and efforts. The locally designed chicken-mesh antenna and front end converter have been used in all the direct reception sets. The experience gained during the experiment is expected to provide insight into the social economic and technological aspects of rural mass communications. The studies are already underway to find out the ways for effective utilization of the ground segment after the one year of experiment is over.

3. Communications, Radars & Navigational Systems

Communications constitute one of the basic infrastructural needs of socio-economic development. During the last 20 years, development of communications in the country has made phenomenal progress in quantitative terms. The number of telephone exchanges and telephones have increased nearly 10 times during this period. Many new services like STD and Telex have been introduced during the last decade. The present production in this sector is around Rs. 74 crores. Given the proper organizational, managerial and technological backup, telecommunication development can therefore be converted not only into a self-sustaining business venture but can also be expected to contribute appreciably to the general revenues of Government over a period of time. The basic operational responsibility for the development of communications rests with the Ministry of Communications. However, as a model body responsible for the development of electronics as a whole,

the Department of Electronics has an important coordinating and promotional role to play in the overall area of communications. The Department works closely with the Ministry of Communications in this respect. The Department was involved in the formulation of the Fifth Five Year Plan proposals for telecommunication development. One of the principal activities of the Department of Electronics is to undertake or initiate, coordinate and monitor, both in terms of R&D and production facilities, suitable promotional measures, with a view to filling gaps in know-how and production, so that the electronic and telecommunication needs of the country are met on the basis of maximum self-reliance. The principal emphasis for increasing the production of telecommunication equipment has been an augmentation of R&D and production facilities already in existence, coupled with efforts to compress the development production cycles for new products. Substantial financial assistance for R&D has also been given by the Department of Electronics to public sector enterprises in the field of telecommunications for technology development.

As per the Industrial Policy Resolution, most of the equipment in this sector is manufactured by the Public Sector Undertakings. Due to their large scale of operation involved, these public sector units have grown a large number of ancilliary units. Also a number of private sector manufacturers now produce a wide variety of professional grade components and subsystems required for the industrial and defence applications. As discussed in the earlier section the public sector units manufacture important items like Radars, Communication Systems, Microwave equipment etc. Radio communication equipment are manufactured by BEL, ECIL, HAL and ITI. A variety of HF & VHF communication equipment are being produced at BEL. ITI manufacture a wide range of telecommunication equipment including microwave links and radio relay equipment. HAL Hyderabad is engaged in the manufacture of air to

ground transreceivers. ECIL has taken up the manufacture of transreceivers.

Telemetry and telecontrol equipment manufactured in the country include power line carrier communication equipment, supervisory remote control systems etc. It can be confidently said that communications sector is expected to grow rapidly to meet the entire requirement of the country.

4. Computers

India's first computer was designed in early 1960's at the Tata Institute of Fundamental Research and since then continuous efforts are underway to develop the necessary expertise and infrastructure for self-reliance in this field. ECIL has already developed and productionized a series of third generation computers. These are being increasingly used for process control, satellite communications and software development. A few laboratories and institutions have undertaken development projects for minicomputers and their applications. A major development project on computer networks has been initiated at TIFR, Bombay funded by Department of Electronics. The production of electronic calculators has been rapidly growing the last five years and many manufacturers in the private sector have come up with competitive models for commercial and scientific use. Presently there are about 250 computers in the country and this number is expected to grow very rapidly during the coming decade. The growth of computers in the country is indicated in Figure 6.1.

5. Control & Industrial Electronics

With the progress in technology, industrial processes have become increasingly complex. It is essential to adopt appro-

priate control systems, so that the operational cost, efficiency and quality are optimized. In the field of instrument servo components the prominent groups are the Servo Control Division at ECIL and Control Guidance and Instrumentation Division of SSTC. Indigenous production of servocomponents has been recently established with the manufacture of servo and hysteresis motors, synchros and rate gyro-packages.

There are about 70 units engaged in the manufacture of process control instruments. Out of this nearly 15 are in the large scale and the rest in the small scale sector. The present production of process control instruments is about Rs. 15 crores per annum. The types of instruments produced in the country cover temperature measurement using mercury, resistance and pyrometric methods, gauges for pressure measurement, strain gauge instrumentation and a variety of analyzers. Instrumentation Ltd., Kota has been producing a wide variety of pneumatic instruments and have recently diversified in the areas of electronic control instruments.

The item manufactured in the field of industrial electronics covers a wide variety of drives, numerical control machines, dielectric and induction furnaces etc. The developments in this field have been rapid and the basic components like thyristors and high power silicon diodes are also being manufactured. Of late new areas in industrial electronics like mining electronics, pollution monitoring equipment and agri-electronic instruments have been identified as having large growth potential. The Department of Electronics has been paying particular attention to these areas in view of their national importance.

6. Medical Electronic Equipment

One of the spin-offs due to increasing sophistication in

electronics is the emergence of a new area called biomedical engineering or medical electronics. An interdisciplinary approach has helped the development of medical electronics for the use of physicians as aids for achieving rapid and better diagnosis and therapy. In India though the field of medical electronics is still in its infancy, it has made a significant start in the right direction. MEE equipment in increasing numbers, are currently used in many hospitals.

The base for production of medical electronics equipment comprises mainly of small and medium scale manufacturers both in public and private sectors. Of the equipment manufactured X-ray equipment constitutes the major share. Some of the other equipment currently manufactured are electrocardiograph, respirator, foetus monitor, hearing aids and stimulators. Many analytical instruments are also being manufactured. The present production of MEE in the country is of the order of Rs. 5 crores.

7. Instruments

A wide variety of instruments like test and measuring, analytical, nuclear, geoscientific instruments are manufactured in the country. The present production is of the order of 11 crores per annum. The test and measuring instruments manufactured include instruments like digital multimeter, admittance bridge, oscilloscopes, communication test equipment etc. Of late some manufacturers have embarked on the programme for the production of TV test instruments. The analytical instruments manufactured include PH meters, conductivity meters, spectrophotometers and colorimeters.

The production of nuclear instruments like GM counters, pulse analysis equipment, reactor control instruments, whole body

counters is mainly concentrated at ECIL, Hyderabad. The present manufacturing base for geoscientific and related instruments is modest, although the demand for these instruments is expected to grow rapidly due to the increasing activity in oil and mineral exploration.

8. Components & Materials

In the field of components the production has been in pace with that of equipment, the production having risen from a mere Rs. 6.5 crores in 1965-1966 to Rs. 81 crores as at present. However, as compared to consumer and industrial grade components, the production of professional components is lagging behind. In the case of consumer grade components, in addition to meeting the local demand the country has also been exporting in substantial quantity. The growth of the electronic components industry in India is depicted in Figure 6.2.

In the area of electron tubes the production includes receiving and transmitting tubes, magnetron, X-ray tubes, TV picture tubes and some types of special electron tubes. In the area of semiconductor devices most of the production today is that of germanium and silicon discrete devices. As regards integrated circuits BEL has recently started the production of TTL ICs with indigenous know-how and is soon starting the production of CMOS ICs with foreign collaboration. A few other private companies are doing the packaging of imported chips. The setting up of the semiconductor complex in the public sector, devoted to manufacture of MOS LSI, bipolar LSI, LEDs and microwave solid state devices have been initiated. In the area of hybrid microcircuits BEL is well equipped to undertake production. Facilities have also been created for hybrid circuits at ITI.

In the area of passive components there are over 40 firms producing resistors of almost all types and about 70 firms making capacitors of different types. The connector industry is coming up with about a dozen manufacturers making coaxial, rack and panel and printed circuit connectors. HAL, Hyderabad produces a few types of rectangular multipin connectors. Relays are being produced in a fairly wide range in the country by about 10 firms. ITI Bangalore make telephone type relays for their telecommunication equipment. Switches which include rotary wafer, push button, toggle, snap action etc. are being produced by 25 manufacturers. The production base is well established for other components like crystals, transducers, magnetic components, printed circuit boards, etc.

So far as the materials are concerned, electronic component industry still depends to a large extent on imports. However, there are few industries producing some types of electronic grade materials in limited quantities. The production of some ultrapure materials and semi-metals has been established at Hyderabad. A wide variety of soft and hard ferrites are already under production catering to most of the requirements. Except some special plastics, like PTFE, DAP and polycarbonate, etc., others are being locally manufactured. Many of the chemicals required for electronics industry are locally available.

6.4 Research and Development in Electronics

Electronics is one of the most R&D intensive areas and the advancement of this technology critically depends on the availability of well organized R&D base in the country. Bhabha Committee in 1966 estimated that the R&D outlay for electronics was of the order of Rs. 4 crores and predicted that by 1975 annual outlay should be of the order of Rs. 85 crores. Although the R&D outlay has been less than the expectations considerable progress

has been made in this direction.

In the field of consumer electronics the R&D efforts have been relatively little. It has been estimated that hardly 0.3% of the total sales have been spent on R&D efforts, CEERI. Pilani has developed technical know-how in TV test instruments, antennas, TV camera monitor, microphones and other items. Many of these have been successfully transferred to the manufacturing base. The electronic systems division of ISRO has developed a solid state TV.

In the field of mass communication most of the R&D work is going on in BEL and AIR, BEL has developed several types of transmitting tubes, high power valves for broadcasting and communication equipment. ITI has been engaged in the development of microwave link equipment. Indigenous efforts have resulted in the development MW transmitters up to 100 KW, TV transmitters and accessories. The development efforts are underway for items like control consoles, studio equipment, TV relay receivers etc.

The development work in the field of computers is underway at TIFR, BARC, ECIL, Jadavpur University etc. The development is also being undertaken for different types of peripherals. Considerable efforts in software development are being made by firms in public and private sectors.

In the field of instruments considerable progress has been made. Extensive efforts have resulted in the development of a large number of items from digital multimeters to complex medical instruments. The existing R&D activities are in several laboratories under CSIR, Department of Atomic Energy, ISRO, Ministry of Defence and some educational institutions. Some process control instruments are under development at ECIL, IL, Kota and Fertilizer Corporation of India. The process control instruments

and computer control systems have been developed.

In the field of communications, a major part of R&D activities is carried out by institutions attached to the user departments and in-house R&D units of various organizations. Telecommunications Research Centre, Overseas communications Service Research Centre, laboratories under Ministry of Defence, R&D departments of BEL, ITI, and HAL account for most of the work done. Significant contributions of TRC are for microwave links, telephone and telegraph equipment, automatic electronic exchange, data modem etc. ITI has developed a wide variety of telephone equipment, line equipment, intercom systems, equipment for stronger and cross bar exchanges and narrow band solid state systems.

In the case of radar and HF/VHF equipment BEL, HAL and LRDE have significantly contributed. A few other laboratories like TIFR, NPL, BARC have been actively engaged in the development of C-band, X-band, S-band systems, transmitters, transreceivers, LOS systems and radio relay stations.

The growth of electronic components and materials industry demands a far greater R&D effort than the sector of equipment. The research groups of BEL, CEERI, NPL, ECIL, IISc etc. have been the leaders in the field. A wide variety of special electron tubes have been developed. National laboratories like SPL, CEERI, NPL have been engaged in the development of semiconductor devices. NPL has been concentrating on thin film technology. A variety of materials including ferrites and ceramics have been developed. The leaders in the materials development have been CEERI, NPL, NCL, RRL, SPL, CGCRI, NAL.

The above brief survey indicates that the R&D efforts have been undertaken in the past by different institutions and labor-

atories. There have been instances of duplication of efforts. In order to foster the growth of R&D efforts in the country so that it culminates into production, the Electronics Commission established a Technology Development Council (TDC) in 1973. The decision was taken following the recommendations at the National Seminar on R&D Policy in Electronics held in January 1973. The principal functions of the TDC is to assist EC/DE in the identification of areas requiring intensive R&D efforts, assigning the relative priorities and helping the transfer of technology.

TDC is assisted by six working groups of experts in different areas of electronics. The working groups have examined a large number of R&D proposals and have recommended some for high priority funding and completion. The TDC is also expected to examine the question of import of know-how and internal transfer of technology.

TABLE 6.1

PROFILE OF PRODUCTION 1966-1975
(In Rs. Crores)

Year	Consumer Electronics & Mass Communication	Telecom- munication Equipment	Aerospace & Defence Equipment	Computers Control & Instrumen- tation	Equip- ment Total	Com- ponents	Equipment Comp. Total
1965-66	24.0	3.0	6.5	3.5	37.0	6.5	43.5
1966-67	32.0	3.2	6.7	6.1	50.0	10.0	60.0
1967-68	40.0	3.5	13.3	8.2	65.0	15.0	80.0
1968-69	48.0	4.7	21.3	11.0	85.0	21.0	106.0
1969-70	63.0	5.0	30.0	12.0	110.0	28.0	138.0
1970-71	80.0	6.0	32.0	20.0	138.0	37.0	175.0
1971-72*	55.0	42.0	28.0	14.0	139.0	41.0	180.0
1972-73	65.0	49.0	30.0	16.0	162.0	44.0	206.0
1973-74	64.0	65.0	35.0	25.0	187.0	65.0	242.0
1974-75	83.0	74.0	52.0	36.0	245.0	81.0	326.0

* Note: Since 1971-72 the classification for production statistics was changed.

TABLE 6.2

PRODUCTION OF RADIO RECEIVERS (in lakhs)

<u>Year</u>	<u>Organized Sector</u>	<u>Small Scale Sector</u>	<u>Total</u>
1960	2.68	Nil	2.68
1962	3.38	Nil	3.38
1964	4.70	Nil	4.70
1966	7.12	3.9	11.02
1968	13.75	7.5	21.25
1969	17.38	8.5	25.88
1970	17.70	9.0	26.70
1971	19.82	10.4	30.22
1972	19.20	11.0	30.20
1973	16.4	10.1	26.5
1974	20.6	14.0	34.60

TABLE 6.3

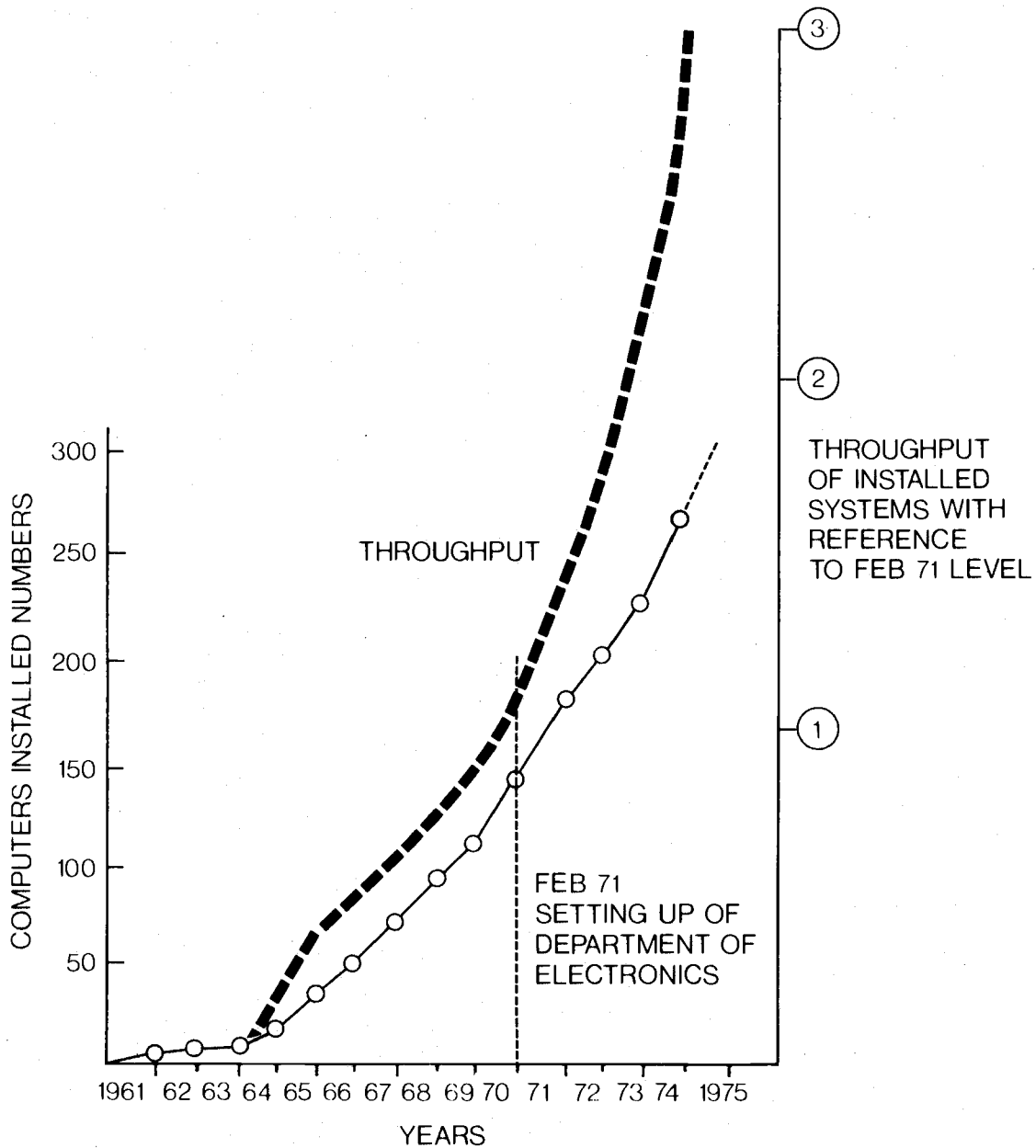
PRODUCTION OF TV RECEIVERS

	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>
Large Scale	5352	7800	14778	28379	26002
Small Scale	9054	8207	15893	46687	49512
Total	14406	16007	30671	75066	75514

FIGURE 6.1

GROWTH RATE OF COMPUTER INSTALLATIONS AND
SYSTEMS THROUGHPUT
IN INDIA 1961 - 1974

NOTE: NUMBERS INDICATED COVER
A RANGE OF COMPUTERS FROM
THE SMALL (TDC-12 ETC) TO
THE MEDIUM-LARGE (CDC-3600-
160 A IBM 370/ISS ETC)



7.0 Industrial Licensing Policy

The Licensing Policy pursued in Electronics follows the basic framework of the Industrial Policy laid down by Government in its resolution of 30th April, 1956. In that Resolution, professional telecommunication and electronic equipment have been largely reserved for the public sector while the rest of the electronics industry has been left open.

The procedure for licensing is that which is laid down in the Industries (Development and Regulation) Act, 1951 as modified from time to time. The licensing of new electronic units was being done by the Ministry of Industry, later by the Electronics Wing located in the Department of Defence Supplies. Later it was transferred to the Cabinet Secretariat under which the Department of Electronics created in July 1970 was located; and with the constitution of the Electronics Commission in February, 1971, a fulfledged Department of Electronics has been set up which, among other things, has been given the responsibility to process all applications for licensing in the organized sector dealing with electronic items. With effect from 1st November, 1973, a Secretariat for Industrial Approvals has been set up in the Ministry of Industry which receives all applications for licensing which are then forwarded to the concerned departments in the Government. In respect of electronic applications, these are sent to DDE and others such as the DGTD, the Development Commissioner, (Small Scale Industries), the Department of Economic Affairs, the Department of Company Law, the Department of Science and Technology, etc. The comments of these are considered by the Licensing Committee and a final recommendation is made largely on the basis of that proposed by the Department of Electronics. After the recommendation has been approved by the Minister for Industry, a letter of intent is issued to the party who can then apply for the capital goods (C.G.) to a Committee

and for approval of foreign collaboration, if any, to the Foreign Investment Board. In respect of both these applications, the views of the Department are taken into account before a final decision is taken by the respective Committee.

The Department has, however, been encouraging entrepreneurs to file "composite" applications where the party makes an integrated proposal which involves simultaneous issue of a letter of intent, approval of foreign collaboration and also the capital goods required for the project. Such an application which necessarily involves more "home work" by the party provides a better picture of the project to the Department which can, therefore, process it in a more meaningful manner. According to the procedure for such composite applications, a Screening Committee presided over by the Joint Secretary of the Department first makes an appraisal of the application after which the Department sends its recommendation to the Project Approval Board in which the Secretary, Department of Electronics is also a member. The Project Approval Board then makes a final recommendation on all aspects of the application and the party can be issued a license within three to four months from the date of filing his application. While normally the recommendation of the Department is given a great deal of weight by the Project Approval Board, it must be admitted that the final decisions of the Project Approval Board (as those of the Licensing Committee or of Foreign Investment Board) are necessarily dependent upon the total view taken by a number of agencies in which the Department of Electronics plays a significant, but not always a dominant, role.

The above paragraphs provide a description of the procedures normally followed in all Departments. But one of the innovative features of the Department of Electronics has been that processing of applications is not done in a routine manner but is dependent

upon a great deal of discussion and consultation with the parties concerned. In this connection, the Electronics Commission had constituted a number of panels in a variety of areas such as Desk Calculators, Ferrites, Semi-conductors, Glass Bulbs for TV picture tubes, Electro-Mechanical Component, Passive Components, Medical Electronics, Electronic Materials, Micrometers, Connectors, Mini-computers, etc. These panels consist of representatives drawn from both Government departments, research and academic institutions as well as the public sector units. The recommendation of these panels are carefully considered by the Department and after approval by the Electronics Commission and used as guidelines for the processing of all applications for licensing. Thus, the Department is able to enter into a meaningful dialogue with the entrepreneurs and makes its recommendation to the various Committees on this basis.

In order to ensure a closer follow-up of the projects after the letter of intent (or industrial license) has been issued by Government, senior officers of the Department hold periodic meetings at the State capitals in cooperation with the State Directors of Industries in order to review the progress made in respect of each project. Other concerned Departments of Government such as the DGTD, the DC (SSI) and the CCI&E are also invited to these meetings. Both the parties in the organized sector as well as the small scale sector attend these meetings and their progress is reviewed in each case. If any difficulties are experienced by the party which can be resolved on-the-spot these are immediately done; where, however, the difficulties involve changes in policy, they are taken up with the concerned Government departments to ensure speedy relief to the entrepreneurs. In this manner, there has been a much closer dialogue with the parties resulting in greater utilization of licenses issued to them in the last three years than there has been in the past.

An important criterion in the assessment of an application is the credentials of the party making such an application. The Department has laid great emphasis on providing encouragement to technically qualified entrepreneurs and applications received from such persons are always given higher priority than those made on a purely investment basis. The Department is also in constant touch with Indians abroad who are engaged in the electronics industry and who have expressed their desire to return to the country to participate in meaningful ventures. After their return, the Department helps them to file suitable applications and process these applications with the speed which is possible in the existing framework of the Government Resolution.

Another important criterion which the Department has been following is to disperse the electronics industry out of the main metropolitan areas of the country. Ever since the industry began in the 1950's, there has been concentration of its growth in three or four centres notably Delhi (for consumer electronics), Bombay/Poona, Bangalore and Hyderabad. In the last two towns, the growth has been primarily as a result of the public sector undertakings located in them. The Department believes that a considerable momentum for further growth has already been generated in these areas and other efforts should now be made to push the electronics industry into the less advanced areas and States in the country. It is, however, admitted that while electronics requires a minimum of infra-structural facilities such as water, power, roads, etc., it does require a good reservoir of manpower both skilled and semi-skilled. Hence, it may not be always possible to locate electronic units in a backward area or district, but on the other hand, in many of the so-called backward areas, a large element of traditional skills are available which could well be utilized for the electronics industry.

It is with this end in view that the Department has been keeping close touch with the State Governments and State Government agencies for the development of electronics in those areas. Senior officers of the Department make periodic visits to State capitals to discuss with the Governments the formulation of State Plans for the development and growth of electronics in their respective States. In order to stimulate this effort further, the Department has been suggesting to State Governments who are keen to develop the industry in, their respective States to consider the constitution of a separate Electronics Development Corporation in their States. This suggestion was first accepted by the State of Kerala which has set up a separate Electronics Development Corporation in 1973. Similar Corporations have since been set up in West Bengal and U.P. and more are in the process of formation in Gujarat and Tamilnadu. The experience of the Kerala State Electronics Development Corporation has indeed been encouraging and a large number of letters of intent have been provided to that Corporation which are expected to be translated into production units throughout the State in the course of the next few years. Similar assistance is being given to West Bengal, U.P. and Gujarat where separate agencies have been constituted to deal exclusively with the development of Electronics.

In addition to the above, the Department has also been encouraging the identifications of "growth centres" in each State which would enable new units both in the organized and the small scale sector to come up at such Centres. In order to assist the State Government further in the matter, the Department had announced in 1972, a scheme to grant Rs. 25 lakhs for the setting up of Testing and Development Centres on suitably located Electronics Estates where a sizeable number of units particularly those in the small and medium sector, exist or are likely to come up. The States' Governments on their part are expected to

provide land and buildings, roughly assessed at 25% of the total cost for setting up such a Centre. The operational expenses for running the Centres are also the responsibility of the State Governments. The response of the States has been heartening. Such Centres have already come into existence on the Vikram Sarabhai Estate set up at Adyar near Madras. Another Centre is functioning at Baroda on the Electronics Estate at Makharpura. Similar Centres are in the process of being set up in Calcutta, Kanpur, Punjab, Rajasthan, Andhra Pradesh, Karala, U.P. and Himachal Pradesh. In Chandigarh and Ranchi, Electronics Estates are being set up which are devoted exclusively to instrumentation which are relevant to the local demand and the skills available in that area. In this manner, there has been a wide spread dispersal of the electronics industry throughout the country in the last three years.

The Electronics Commission has given considerable thought to the role of the large, medium and small units in the further growth of the electronics industry. The production of electronics equipment which are basically assembly operations can be done in the small scale sector with minimum overheads and infrastructure. It is for this reason that special encouragement was given to the production of TV receivers in the small scale sector and the success of some of the models made in that sector has amply proved that scale of operations is no criterion of the ultimate success of such ventures. On the other hand, where the production process involves utilization of automatic machinery which determines the total capacity of the unit, it is felt that the small scale sector may have a disadvantage compared to the large scale one. Thus, in the production of electronic components it may become necessary for much larger volumes of production to be set up than is possible with the limitation of capital investment inherent in the small scale sector. The Department has, therefore, been encouraging the

further growth of the component industry in the medium and large scale sectors with considerable amounts of export orientation.

Another important aspect to which the Department has given considerable thought is the role of the foreign companies in the growth of the electronics industry in India. In this connection, it may be pointed out that companies with substantial foreign equity ranging from 49% and above have played an important part in the spread of the consumer electronics in the initial period. It is only in recent years that the emphasis has shifted in the electronics industry from purely consumer electronic items such as radios amplifiers to professional electronics and computers; whereas in 1965-66 consumer electronics represented as much as 60% of the total electronics items, in 1973-74 it has dropped to around 25%. It is expected that in the Fifth Plan period, the main thrust for the further growth of electronics will be in the area of professional equipment and component as well as computers and industrial electronics.

It is possible to group the foreign companies operating in the electronics area into four broad categories:

- i) Those which are wholly owned by foreign companies or are subsidiary to them. The outstanding example of this category is IBM whose Indian operations are controlled as a branch of the IBM World Trade Corporation with its headquarters at New York; similar is the case with CIL (marketing) Ltd. A few other companies such as those of ASEA and ERICSSON are also in the same category but these are comparatively small and operate in specialized fields.

- ii) Companies in which the foreign companies have a majority equity participation: in this category are such companies as Siemens, Philips, English Electric, Gramophone Co., and International Computers (India) Manufacturers Ltd., in which the foreign equity percentage is around 60%. All these companies have played a significant role in one or the other aspect of Electronics Industry. For instance, Siemens has been prominent in the field of Control Equipment, Philips in Consumer Electronics and Components, English Electric in Instrumentation, Gramophone Company in the production of gramophone records and International Computers (India) in the manufacture of Computers and Peripherals.
- iii) Companies in which the foreign equity content is substantial but not in a majority (i.e. below 50%): these are companies such as Bush India, Murphy India in both of which Rank-Xerox have participation of 40% and less as well as newer companies such as O/E/N with participation of 45% etc.
- iv) Companies in which the foreign equity content is comparatively small (i.e. less than 30%).

The Electronics Commission has been critically examining in the past few years the role of the foreign companies in the growth of the Electronics Industry in the next few years. It has laid down two primary criteria in this regard: a) obtaining significant technological gains through the operations of these companies which are not otherwise easily obtainable; or if obtainable, only at a much higher cost; and b) earning of significant

foreign exchange through export by these companies. The Commission is of the view that companies with high foreign equity should certainly be able to contribute to one or both of these aspects. Even where substantial exports are involved in areas of low technology, the Commission has felt it necessary to safeguard any possibility of such companies getting a foothold in areas normally barred to them. Where a particular item is reserved in the small scale sector, there is an automatic imposition of export obligation of 75%. But even in cases where the item is not specifically reserved in the small scale sector, substantial export obligations are being imposed on companies with high foreign equity in order to counteract the outflow of foreign exchange through dividends and royalties. It is also being ensured that since the exports are for a limited period of five to ten years, the possible later adverse impact on the Indian domestic market should be counteracted and a potentially high-growth local market is protected for the indigenous industry.

It is on the basis of these considerations that the Electronics Commission had taken major policy decisions in the last few years, in regard to the further growth of foreign companies in areas which are considered "soft" from the technological point of view, or which offer substantial scope for local entrepreneurs particularly those who are technically-oriented. In the Television Receiver Industry, it was, therefore, decided that companies with substantial foreign equity such as Philips, Murphy or Bush need not be given licenses in view of the fact that their brand names are likely to inhibit any growth of the industry on purely indigenous lines. Again, in the field of electronic desk calculators, the licensing both in the organized and in the small scale sector has been done primarily to indigenous companies and entrepreneurs. In both these areas, there has been a significant growth of local entrepreneurship in the last two years because of

the fact that these areas have been virtually demarcated for indigenous industry rather than those in which foreign technology and brand names are likely to play an important part.

The Electronics Commission has also given careful thought to the possible future avenues of growth in regard to the foreign companies. It has considered that while on the one hand there is need to protect the indigenous industry from the adverse impact of the working of these companies, it should also be ensured that such companies who have access to the latest technology as well as marketing channels should be enabled to play their part in the growth of the Electronics Industry in the country. This is particularly so in regard to export earning where the companies producing items with internationally known brand names can find wide export markets all over the world. One has, therefore, to balance the outflow of foreign exchange due to dividends and royalties as well as the inhibiting impact of the foreign companies on the indigenous industry with the advantages of having access to new technology as well as to wide export markets.

The Electronics Commission had taken up the role of the IBM in Computer area for a series of discussions with the company. Based on these discussions, the Commission had decided that IBM who control 60% of the total world market and 74% of the Indian market cannot be allowed to continue on the basis of importing used machines and refurnishing them without at the same time being willing to dilute their foreign equity according to the guidelines laid down by the Government of India. It was, therefore, decided in 1971 that the manufacture of the "AS-IS" machines has to be phased out and this is now being implemented.

On the other hand, it was felt that a company like IBM should

take up the production of items on a 100% export basis. They are now manufacturing key punches (no. 129) which are fetching significant exports to the country. Thus in 1972-73, the export of such punches as well as Unit Record equipment was of the order of Rs. 182.56 lakhs and in 1973-74 exports amounted to Rs. 322.42 lakhs. It is expected that for some of these products, IBM will act as one of the key sources for export throughout the world.

In regard to the second category of companies, the Commission has been laying down specific policies after careful examination of the areas of strength of each of the companies. Thus in regard to Philips, a negotiating team was appointed in 1972 in which the Ministry of Industrial Development was also represented. Philips (India) was required to submit their programme of future activities and these were then discussed with the Company. Based on these discussions, the negotiating team submitted a report to the Department in June 1973, which was considered by the Electronics Commission subsequently. As a result of these discussions, all the pending applications which the Company had made in the last three years have been processed and letters of intent recommended in specific cases. Further, in accordance with the recommendations made by the negotiating team, the Department of Electronics has taken the view that the Company may be allowed substantial expansion or entry into the fields of professional components and equipment for which there is likely to be a significant demand in the Fifth Plan period as well as areas where substantial exports are possible. One hundred percent export proposals for Variable Gang Condensers, Amplifiers, Intercommunication Equipment have recently been cleared by the Cabinet Committee on the recommendation of the Licensing Committee. There will also be a substantial increase in the earnings of foreign exchange through exports of products made by Philips

(India) to other countries where the principals of the company operate.

A similar exercise is also being attempted in regard to other Companies in this category. Siemens, English Electric and ICL are being advised to map out specific programmes for producing equipment which are either technologically sophisticated or which can be exported in considerable numbers. It is felt that as a result of this exercise these companies will play an important role in meeting the indigenous demand for items currently imported and also for undertaking exports of such items.

In the third category all companies where the foreign equity content is substantial but not a majority either numerically or in terms of Foreign Exchange Regulations Act. Thus, Bush India has 40% equity and Murphy India 38% equity content in them. Both of these companies have a substantial share of the radio market for many years but are now being advised to shift their intention to either technologically sophisticated products or for significant exports. Bush India has been approved for the manufacture of pocket calculators and car radios with export obligation as high as 90%. Murphy is also planning to manufacture items which are either meant for exports or which are technologically more complex. Both these companies have developed, over the years, considerable expertise in marketing and management and the Department expects that this expertise will be utilized in tapping markets abroad particularly in Western Europe and the United States.

In the last category are companies whose foreign equity is currently below 30%. The Department has consistently taken the stand that where indigenous know-how is available, it is not necessary for parties to obtain foreign collaboration except

where such collaboration becomes useful either for introducing new technology or for undertaking substantial exports. Even in cases where collaboration is considered desirable, the Department, in accordance with the policy of the Government, consistently advises parties to make payments of technical know-how fees and royalties according to approved norms rather than encourage investments by foreign collaborators. Where such investment, however, becomes absolutely necessary these are being kept at as low a level as possible.

The Electronics Industry today in the country is on the points of take-off and has a potentiality for high growth in the next few years. It is, therefore, necessary to critically examine the activities of all foreign companies in the field of Electronics so as to determine the role which the Government would like them to play in the development of the Electronics Industry in the country. The Department is also exercising vigilance so that foreign majority companies do not distort the structure of capital investment by Indian companies through purchase of shares or by diversification into areas of trading or commercial activities which are likely to have an adverse impact on the growth of indigenous industry. For this purpose, the Department keeps in close touch with the Reserve Bank of India with a view to ensuring that the powers conferred on the Reserve Bank of India through the Foreign Exchange Regulations Act are utilized in a meaningful way. Broadly, the Department has taken the view that foreign companies may be allowed to continue operations (or even expand them) for the benefit of the country as a whole; but they cannot, and must not, be allowed to inhibit the growth of indigenous industry particularly in the small and medium sectors.

It may be mentioned that the Electronics Industry is bas-

ically low in investment but high in know-how requirements. What is needed as input from abroad is not so much foreign investment in terms of capital but more in terms of technological know-how to keep pace with the changing trends of the industry in the advanced countries. Another important area in which know-how is essential to the growth of the industry is export marketing capability particularly in the context of an acute shortage of electronic products in many parts of the world. Foreign companies can play a useful role in meeting the worldwide shortage of goods by producing in the country some of these items and marketing them in the developed countries. The Department of Electronics keeps in close touch with the technology trends and markets abroad to see how best the latest technology could be brought in the country as well as exports undertaken without at the same time being burdened with high equity investments.

8.0 Exports Promotion

The exports in electronics from this country started in a small way in 1968 with a few parties exporting radios. However, these exports had more or less saturated at Rs. 3 crores per year by 1970-71. The first phase in broad-basing and strengthening electronics exports began in 1971-72 and has resulted in increasing the number of significant exporters from about 5 to nearly 40 and an increase in the value of exports from about Rs. 3 crores to about Rs. 6 crores by 1972-73. Table 8.1 indicates the exports growth profile over the last four years.

The possibility of making electronics exports viable in their own right was recognized, mainly on the basis of the confidence that a number of sophisticated items requiring highly skilled labour and high quality engineering inputs could be exported from India. This was stressed to the industry with the result that a new group of exporters have now emerged with a new range of products for export. Some of these products are:

- a) Amplifier systems and components
- b) Car radios
- c) Laboratory instruments
- d) Radios from small scale consortium operations
- e) Electrolytic capacitors
- f) Plastic film capacitors
- g) Mica capacitors
- h) Resistors
- i) Printed circuit boards
- j) Semi-conductor devices

These show that the base of electronics exports has been considerably strengthened in the last few years through induction of new exporters and new products.

8.1 Future Prospects

Electronics exports during the Fifth Five Year Plan is expected to grow at a much faster rate than higher to, due to the setting up of a diversified export base and the current effort of promoting new export-oriented projects of large size. Total exports during the Fifth Plan are expected to be about Rs. 117 crores, excluding exports from Santa Cruz and other electronics export processing zones, which might become operative during the Plan period. The prospects for electronic exports during the Fifth Plan can be categorized as indicated in Table 8.2 (excluding contribution of export processing zone).

The new export-oriented projects referred to in 8.0 have been brought about during the 15 months from June 1973 to September 1974. At the same time, firm directions regarding licensing policies to be followed for such projects have already been arrived at by an inter-departmental Working Group Constituted by the Ministry of Commerce and convened by the Department of Electronics. The report of that Working Group has already been submitted to Ministry of Commerce. With these clear policies on hand, it is expected that at least 10 more major export-oriented projects can be promoted which would contribute something like Rs. 30 crores by way of exports over the Plan period.

8.2 Number of Exporters and Items with Export Potential

According to available information, there are about 70 exporters of electronic products, out of which information is available on the export figures of 49 exporters. During the year, an Export Working Group constituted by the Ministry of Commerce and convened by the Department of Electronics considered the future prospects of electronic exports from the country after

taking into account all related aspects such as indigenous technology, availability of raw materials, production capacity etc. The Working Group which submitted its report to Government in April 1974, has not only made a number of specific policy recommendations but also identified a list of items having potential for export.

8.3 Santa Cruz Export Processing Zone (SEEPZ), Bombay

To take advantage of the growing world trade in electronics, the Government of India has set up a 100% export-oriented electronics export processing zone in an area of about 91 acres at Santa Cruz, Bombay. The project was approved by the Cabinet in November 1972, and work started on it soon after. The project is designed to attain its optimum level of production in 1977-78 when it is expected to reach an average annual rate of export of about Rs. 50 crores with an average value added around 50%.

It is necessary to emphasize the difference between the kind of export-oriented activities envisaged for SEEPZ and those characteristics of export processing zones established in several other countries. In the latter, large foreign financial investment mostly through multi-national companies, is solicited; projects involving very large turnover, but small value added are permitted. The basic thrust of such operations is merely the use of the cheap labour. In the case of SEEPZ, large foreign financial investments are not being solicited. Furthermore, only high added value projects, involving effective transfer of know-how are permitted. Foreign investment is permitted only where a substantial marketing capability is brought with it. The high added value ensures that the projects largely involve quite a high level engineering skills and capabilities. Thus the projects envisaged for the zone have value added components in a

range of 30 to 70% of F.O.B. export price as compared to 10% or lower, which would be the case if only simple semi-skilled operations are performed locally. The intrinsic advantages of going for a high value added approach of this kind are:

- a) the foreign exchange earning arises not merely from the use of our relatively cheaper labour, but also from the use of local components, materials and engineering skills;
- b) the kind of operations which develop are those that ensure products with some stability in the export market rather than products having transitional export markets to be met by a large labour force that can be temporarily employed and then retrenched;
- c) transfer of technology at high engineering levels in cases where foreign collaborations are involved in the operation.

Import to and exports from the Zone are duty free. Exports for the domestic tariff area to the Zone are treated as normal exports for the country and are eligible for all the prevailing export incentives. It is hoped that this will enable India companies in the domestic tariff area to maximize their supplies of raw materials, components, sub-assemblies parts etc. to enterprises in the Zone, thereby earning additional foreign exchange for the country due to the presence of the Zone.

It is too early to make any assessment about the success or otherwise of the Santa Cruz Electronics Export Processing Zone Project as it is still in its formative stage and most of the

units which have been approved are taking steps to implement their projects. However, due to the present recession in the electronics industry all over the world, entrepreneurs are proceeding cautiously. The progress of the Santa Cruz project is constantly under review. According to the current assessment, the annual exports from the Zone are likely to grow and by the end of 1977, would be about equal to the normal electronics exports from the rest of the country, i.e., between Rs. 10-15 crores.

TABLE 8.1

EXPORT GROWTH PROFILE

	1971-1972	1972-1973	1973-1974	1974 (Calendar Year)
Total	5.27	6.79	7.5	11.58
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Estimated Profile for the Export of Electronic
Items During the Period 1974-1979 (in Rs. Crores)

	<u>Source of Exports</u>	<u>Total Exports</u>
1. Existing export base		60
2. New export avenues opened by public sector enterprises		30
3. New export oriented projects initiated recently		25
4. Software export		2

Total:		<u>117</u>

9.0 Manpower for Electronics

9.1 Introduction

The Electronics Industry in India is poised for a major growth during the next decade. Rapid technological changes are leading to a requirement of manpower which should be highly skilled and more adaptable. The social changes -- including changes in the education system, are altering the pattern of supply of human resources in ways which may not always be in time with the technological requirements. To ensure that the supply of trained personnel matches with the future demand it is imperative to take up the problem of manpower planning on a priority basis.

A developing country's demand for highly qualified and skilled manpower is as important as the capital itself. To ensure that the lack of qualified personnel does not serve as a bottleneck in the growth of the industry, long-term projections regarding the requirement of these personnel need be worked out and training programmes initiated to meet the future demand.

While planning for manpower, knowledge of labour productivity is essential. Labour productivity can be considered as a set of technical coefficients, which in effect establish connections between the output of different sectors of an industry and the most important resource, labour. It is, in the most general sense, volume of income per employed person. When employment cannot be increased substantially or can be increased only in the long run, the economic development will depend on productivity increases. This is the case with many developed countries. The situation is rather different in the case of developing countries like ours -- which have vast amounts of human resources and where the production is labour intensive in-

dustries, like the Electronics Industry for example, can be increased through substantial increase of employment. It is, however, not always advisable to maintain a low level of productivity and raise the production, only by an increase in employment. This may affect the healthy growth of the industry.

It is possible to estimate the requirements of manpower for any industry, provided, the future targets of production are set. However, additional information regarding the trends in productivity, the level of technology being used and the existing policies in its industrial development is also essential. A certain level of technology, hence productivity, are represented by a specific kind of organization and a specific kind of capital equipment that is made to work by the labour force. The skill composition of this labour force is also fairly well defined. Management of organization, control of production, for example, are the main tasks of administrative, scientific, technical and other highly qualified personnel. From the production point of view, the skill requirements of the workers in any industry are of the following three types: i) skilled, ii) semi-skilled and iii) unskilled. The relative proportion of these employees in an industry depend on the techniques being adopted for production in its various sectors.

The Bhabha Committee envisaged that the average wage bill for producing electronics equipment would be 38% of the sale value of which the wage bill for those engaged in direct production, engineering supervision, design and development in the plant would be about 28% while the wage bill for auxiliary staff engaged in stores, purchase, and administration would be about 10%. The output per person employed for the manufacture of equipment in the Electronics Industry, including all supporting and auxiliary staff was estimated to be Rs. 9,000 against Rs. 12,000 for a

person directly employed in production. As the Committee envisaged a production of Rs. 300 crores worth of electronics equipment by 1975, the total manpower requirement was foreseen to be 330,000 with the skilled workers, technical staff and engineers number 250,000.

For the production of Rs. 300 crores worth of equipment the production of roughly Rs. 84 crores worth of components was envisaged. The output per person employed in the components and other process oriented industries was assumed to be about double that for the equipment industry. On this basis the total number of persons employed in the component production industry, in 1975, was estimated to be about 40,000 with skilled workers and technical engineers numbering about 32,000.

An additional manpower comprising of about 15,000 scientists and engineers and 30,000 supporting technical staff was envisaged for research and development activities in laboratories and research institutes outside the plants.

Thus it was expected that an investment of Rs. 170 crores would provide employment in the Electronics Industry for some 400,000 scientists, engineers, skilled workers and personnel in the supporting staff. The per capita investment being about Rs. 4,000. Though to a large extent, we have achieved the production targets set by the Bhabha Committee, this is not the case as far as the manpower employment in the industry is concerned. It is estimated that at present about 120,000 persons are engaged as the production and supporting staff. This is only about 30% of the projected figure. The main reason for the Bhabha Committee's estimates going astray is the increase in per capita productivity. At present the average per capita productivity for the electronics equipment industry is about Rs. 30,000 while for the com-

ponent industry it is Rs. 15,000 approximately.

9.2 Indian Public Sector Experience

An idea regarding the organizational structure in the Indian Electronics Industry can be obtained by looking into the staffing pattern in some large scale manufacturing units like BEL and ECIL. Bharat Electronics Limited is primarily engaged in the manufacture of communication equipment, including broadcast transmitters, radars etc., electron tubes, semiconductor devices and TV picture tubes. Their production during the year 1972-73 was about Rs. 39 crores. The total number of personnel employed is around 14,000, with the per capita productivity of about Rs. 30,000. More than 75% of the staff is directly employed in production units, while the remaining 25% is engaged in activities like administration, accounts, stores. About 65% of the employees are either scientists/engineers or skilled workers. The scientists, engineers, diploma holders and graduates account for about 8% of the staff. The strength of unskilled and non-technical staff is nearly 12% of the total employment.

The ECIL with an annual turnover of about Rs. 6.6 crores (1972-73) employs about 3,300 personnel. Per capita productivity during this year was Rs. 20,000 approximately. The Corporation is engaged in the production of passive components, semiconductor devices, television, computers and medical electronics equipment. The administrative staff accounts for more than 15% of the employment. About 73% of workers are engaged as scientific and technical personnel while the remaining are in the unskilled category.

At present the per capita investment in the Electronics industry is estimated to be about Rs. 9,000.

9.3 Employment Potential of the Indian Electronics Industry During the Fifth and Sixth Five-Year Plans

The Electronics Industry in our country being predominantly labour intensive, the occupational structure is expected to be considerably different from the one in the developed countries. It has a very high employment potential for skilled and semiskilled workers as a majority of the manufacturing units require manual skill. At present the semiskilled staff accounts for more than 60% of the total manpower employed in the industry. The proportion of the inplant and white collar workers differs from one sector to the other as it depends on factors like the extent of industrial automation, the usage of subassemblies etc. From the ten year profile given by the Information, Planning and Analysis Group of the Electronics Commission on the basis of extensive data available through the Task Force VII and other numerous analysis, information and technical panel reports, the additional manpower required by the end of the Fifth and Sixth Plan periods has been estimated.

An electronics equipment production of Rs. 510 crores (base financial year 1973-74) is envisaged during the terminal year, 1978-79, of the Fifth Plan period. The total value of the component production during the same period is expected to be Rs. 182 crores. The production in these two sectors by the terminal year (1983-84) of the Sixth Plan is estimated to be about Rs. 1,100 crores and Rs. 404 crores respectively.

The present per capita productivity for the electronics equipment industry is about Rs. 30,000 while for the component industry it is Rs. 15,000. During the terminal year of the Fifth Plan the productivity per person is expected to increase and go up to Rs. 35,000 for the equipment industry and Rs. 20,000 for

the components. These ratios, however, give a detailed breakdown of manpower requirement in each sector. In Table 9.1 the estimates for the additional (direct) manpower required during the Fifth Plan period are given. The numbers given for the various sectors of the industry and the occupational structure were estimated from the existing manpower employment figures in the various public and private sector enterprises. Allowance has been made for the increase in productivity per person due to technology development. The employment potential of the industry is anticipated to be 1.86 lakhs during the Fifth Plan period. The semiskilled personnel alone account for 60% of the total employment. These workers are to be engaged in jobs like assembling and machining. The demand for the scientists/engineers/diploma holders will likely be about 14,500 while 24,500 skilled workers will be required.

The increase in employment during the Sixth Plan period is expected to be less than the corresponding increase in the output, due to the improvements in the production techniques, per capita productivity is expected to increase further. The partial growth of mechanization and automation of assembly line operations, the increased usage of integrated circuit technology and the associated miniaturization will reduce the demand of semiskilled workers to some extent. The employment of engineers, scientists, skilled workers and administrative staff is expected to increase. In Table 9.2 the estimated additional (direct) manpower requirement for the industry, during the Sixth Plan period is given. The industry is expected to generate an additional manpower requirement of 2.14 lakhs. Table 9.1 and 9.2 reveal that the semiskilled labour will account for only 56% of the additional manpower during the Sixth Plan period as compared to 60% in the Fifth Plan period. It is anticipated that the demand for scientists/engineers/diploma holders and skilled workers will be 18,500

and 33,000 respectively.

The total wage bill by the terminal year of the Sixth Plan period is expected to be 30% of the production during the same period.

It is expected that the production of Rs. 2,300 crores worth of electronics equipment and components during the Fifth Plan period will provide an additional (indirect) employment to about 70,000 persons. This number will reach to about 100,000 by 1983-84 provided the projected production of Rs. 5,560 crores worth of electronics equipment and components during the Sixth Plan is achieved. The indirect labour will mainly consist of servicemen and maintenance workers.

Hence the growth of the Electronics Industry is expected to generate an additional employment of 2.5 lakhs and 3.1 lakhs persons during the Fifth and Sixth Plan periods respectively.

9.4 Role of Technical Education

Technical education aims to train individuals so as to make them suitable for the requirements of industries and technical professions.

Technical personnel are trained for:

- i) Management
- ii) Production
- iii) Development and design
- iv) Teaching
- v) Research (basic and industrial)

The successful and efficient functioning of an industry

depends upon the availability in adequate numbers of highly motivated managerial personnel. Production management is a set of general principles for production economics, facility design, job design, schedule design, quality control, inventory control, cost and budgetary control. Agencies like the Administrative Staff College, Indian Institute of Management, National Academy of Administration have a vital role to play in the training of such personnel.

The operation of a modern industrial complex on an economical scale is to a large degree a function of the creative productivity of its engineers and scientists. These personnel are required to look after the following aspects in an industry:

- i) Plant installation
- ii) Design and manufacture of tools and products
- iii) Design and fabrication of assembly
- iv) Control of production and design of test jigs
- v) Process control
- vi) Maintenance
- vii) R&D activities

The aim of practical training programmes is to provide the student with an understanding and appreciation of:

- i) The potentialities of basic workshop processes,
- ii) Properties of materials used in engineering workshops and
- iii) General principles of organization and management

Like any other training schemes, practical training programmes can be split up into three phases, namely, induction, basic training and secondary training. The short induction

period is meant to give the student an introduction to an industry/establishment of the type in which he would get his further training. The basic training is to impart the necessary fundamental skills while the secondary education is meant for broadening of technical knowledge and the gaining of insight into some of the workings and problems of the industry in general.

The relative proportion of skill acquired in the overall education depends on the type and level of education. It is the job of the technician to interpret and work out the details of plans, designs or programmes, to determine the techniques tools, machines and processes best suited for the job. In most cases, technicians are required to supervise the work of skilled craftsmen and acts as a liaison between a skilled worker and technologists. The polytechnic trained personnel are required for these jobs as well as for the use of sophisticated instruments and machines. The technician thus combines specialist knowledge experience and skill with an ability to apply them.

The Industrial Training Institute (ITI) trained student is placed at the skilled workman level to work on the tool room and other precision machines. They are also suitable for maintaining production machines and routine type of test and measuring instruments.

The semiskilled workers are required to work on the assembly line operations. The essential requirement being i) ability to take minor decisions, ii) good reflexes, iii) close coordination between hands and eyes, iv) efficient handling of small parts, and v) handling of special assembly tools etc. To become proficient in their job they require a few weeks to a few months of intensive training.

As ascertained by the Bhabha Committee there is very little scope for the employment of unskilled labour in the Electronics Industry, except in an auxiliary capacity.

9.5 Present Status of Availability of Trained Manpower

Degree Courses

The number of institutions conducting the degree courses or equivalent in engineering and technology is nearly 140 with the sanctioned admission capacity of about 21,500 students. This is nearly 30% less than the one existing during the early 1960's. The decision to curtail the admission capacity was taken as a remedial measure and to cope with the problem of unemployment among technical personnel. At present the yearly admissions are about 20,000 with an annual turnout of 15,500 students. Nearly 25 institutions are offering degree courses in electronics and communications and other related areas with an annual turnover of more than 900 graduates.

Diploma Courses

At present there are 284 polytechnics conducting diploma courses in engineering and technology the existing admission capacity is 43,300 students. About 36,700 students are admitted every year while the yearly turnout is 15,200 students. In addition there are 24 women polytechnics in the country with sanctioned admission capacity of 2,500 students. The annual turnout from these institutes is about 950 students. Out of the 308 polytechnics only 42 are equipped with facilities for training in electronics trade.

The share of electronics, telecommunication and other

allied fields is as follows: Against the total admission capacity of 1,350 students the yearly admissions are about 1,450, while the annual turnout is 550 students.

ITI and Other Apprentice Training Centres

The availability of a skilled labour force, well trained to man the different types of machinery, tools and equipment, constitutes an integral part of the industrial development in large, medium and small scale industries. The Directorate General of Employment and Training is charged with the task of training skilled workers required for the different sectors of the economy as well as for self-employment. While the Central Government is responsible for laying down the policies and training standards, training of instructors and industrial supervisors, trade tests and administration of training under the craftsmen training scheme and allied programmes, however, rests with the State Governments.

The vocational training programmes, at present, are being conducted at the craftsmen and supervisory level under the craftsmen and supervisory level training scheme. Training is provided in 32 engineering and 22 non-engineering trades in 357 Government Industrial Training Institutes. The period of training for some of the engineering trades is two years while for the remaining engineering and non-engineering trades, it is one year. Out of ITI's 357 seats, only 24 undertake training in the field of electronics. The mechanic radio and TV and electronics/communication. The total number of seats available for these two trades in the country are 3,200 and 530 respectively. Besides this there are 52 apprentice training centres conducting courses in the electronics trade. At these centres 16 to 20 weeks of on-the-job training is given to the students. Apart from this, many private training institutes conduct courses in radio, TV wiring and ser-

ving. For meeting the demands of instructors needed in the ITI and apprentice training programmes, seven Central Training Institutes for instructors located at different parts of the country conduct regular, refresher and retraining programmes for approximately 1,200 trainees per year.

The Advanced Training Institute, Madras set up in collaboration with United Nations Development Programme imparts training in advanced vocational skills. The Foremen Training Institute (FTI) established at Jangalore with West German assistance is responsible for conducting training programmes for shop foremen on the shop floor.

9.6 Anticipated Gap in the Demand and Availability of Trained Manpower

In view of the job requirements of scientists/engineers laid down in Section 6 of this report, only about 30% of the total number of persons required in this category need be electronics telecommunications engineers, the remaining being specialists in other areas like mechanical, electrical and chemical engineering, material sciences, ceramic, glass technology, metallurgy, physics and chemistry. Physicists, with postgraduate degrees, provide a sizable supply of electronics scientists. At present more than 40% of the postgraduate students in physics specialize in electronics/wireless and about 10% in instruments. The majority of the students specializing in solid state/nuclear physics, which accounts nearly for 20% of the total, have strong background of theoretical and/or experimental knowledge of electronics. Thus more than 70% of the annual turnover of postgraduates in physics are suitable for absorption, either directly or after a few months of on-the-job training, in the Electronics Industry. In view of the existing programmes in science, engineering and tech-

nology, it is anticipated that the demand for personnel in this category will be met with. The existing curriculum, however, needs to be modified. The future training programmes will be discussed in the next section.

A shortage of skilled personnel is anticipated. This may be a bottleneck in the growth of the industry. Even the developed countries are faced with the shortage of skilled labour. In our country we do not have adequate training facilities for tool makers as well as mechanics. It requires about two to three years for an ITI trained personnel to become proficient in this field. The existing admission capacity should be increased considerably in view of the future requirements. The curriculum in these institutes also needs updating.

The demand for semiskilled personnel though large is not likely to create any hinderance for the future development of the industry. These workers need a **few months** of on-the-job training which can be taken up after their recruitment in the industry.

9.7 Future Training Programmes

Managerial Level

The various functions required of a production manager were enumerated in Section 9.0. Their relative importance, however, varies, depending on the nature of individual production unit. Nevertheless each sector has these problems in some degree. The following are some of the broad areas in which the management personnel need be trained:

- i) Management control and planning of enterprises.

- ii) Management and planning of development programmes.
- iii) Methodology and techniques for economic planning, and
- iv) Training and orientation of managers and supervisors in relation to two basic management tasks, namely reduction in cost and increase in productivity.

Engineering Level

With the expansion and diversification of the Electronics Industry in India and the growing need for self-reliance in this field there has been a continuing demand for electronics engineers who have specialized in the design and development of electronics equipment and systems. This demand is particularly pressing in the fast growing areas, such as television, computers, communications, instrumentation and industrial electronics which are poised for major growth during the next decade. In view of the worldwide trends in electronics, it will be prudent that a few institutions conducted specialized courses in the design, development, application and use of semiconductor electronics and integrated circuitry.

Presently there are instances where the same subject is taught to different standards in different institutions. There is need to have a uniformity of standards. The training programmes should be constantly reviewed to include technological development that takes place in the fast growing of electronics. At present the training of engineers tends to be more theoretical with less emphasis on practical work. The design and laboratory

work should be oriented towards inculcating a habit of engineering methodology such as dealing with open-ended problems, decision-making and innovation. Though it is the job of a designer to establish the minimum possible cost of producing a part/or product, the responsibility of minimizing the production costs within the limits of design falls upon the engineers. The obvious time to start thinking about basic models of production of these parts/products is while they are still in the design stage. Thus a designer should have a sound knowledge of production practises also.

Currently there is a shortage of instrumentation engineers. The demand for these personnel is expected to increase during the next decade. Instrumentation engineers are required to undergo a broad training encompassing a number of disciplines in science and technology as well as in technical skills of high order. In view of this a modification and augmentation of existing courses is necessary. At least five institutions of the degree level and ten at the diploma level are required to offer programmes in process control instrumentation. The annual intake of each institute could be 25 and 40 respectively at these two levels. The Department of Electronics is providing technical support for the setting up of an Advanced Training Institute for electronics and process control instrumentation at the Central Training Institute for Instructors at Hyderabad.

Manpower requirement for medical electronics is of varied and diverse nature. Design and production engineers in sufficient numbers will be required to undertake the development and manufacture of these lifesaving equipments. This requirement can be met only if the universities and ITI's offer full-fledged medical electronics programmes to students at B. Tech. and M. Tech. levels. The industry can also coordinate with educational institutions and

hospitals in setting up training programmes and workshops. Students should be encouraged to take up summer jobs for working in hospitals. Given the need for the industry to meet the demand target as also for the hospitals to keep well maintained equipment in its repository, the necessity to train a corps of skilled technicians becomes imminent. It might be mentioned that according to the findings of a recent survey, lack of skilled personnel has been one of the factors that is responsible for nearly 60% of the equipment to be out of order. For a proper, complete utilization of equipment operators should be trained on-the-job for a minimum of six months to one year while imparting nuances of life-saving equipment. Diploma holders should be trained in maintenance aspects for upkeep of medical electronics equipment. They should also be given rudimentary courses in medical physiology.

Based on the demands of the semiconductor industry, curriculum for training programmes should be developed. Besides the theory courses on semiconductor devices, microelectronics and computer-aided design laboratory facilities for semiconductor device technology covering oxidation, photolithography, diffusion, vacuum techniques and thick film techniques are desirable for training students.

Minicomputer networks and midcomputers with a number of intelligent terminals are planned to complement a small number of maxicomputers during the next decade. This requires development of expertise in areas of network engineering, maintenance and management. Among the wide range of minicomputer application are process controls, data communication and instrumentation control which require elaborate systems and application software for time-sharing data acquisition, on-line control communication and the like. This needs specialized programmes with engineering background.

A training centre in electronics design is being set up as a joint venture between the Indian Institute of Science, Bangalore and the Swiss Federal Institute of Technology ETB, Zurich. The collaboration between the two institutions is expected to continue for a five year period. The aims of this centre will be the training of engineers with B.E./M.E. degrees in electronics/communication engineering for a period of one year in the conception, design and fabrication of electronics equipment and systems. The following is the list of typical areas to be covered:

- a) Television circuitry
- b) Instrumentation systems
- c) Telecommunication equipment
- d) Digital and computer electronics
- e) Biomedical electronics
- f) Industrial electronics

Students attending this training programme will spend 50 to 70% of their time on one/two projects; during the remaining 30 to 50% of their time they would receive instructions/lectures as a backup for their project work. To start with 20 students will be trained each year, the number rising to 40 after three years of collaboration. Furthermore, a certain number of student's projects would be fitted into the framework of some industries for mutual benefit.

Vocation Education

In contrast with basic general education which tends to spread a common culture mainly with a view to social cohesion, the aim of vocational education has so far been to prepare workers for specific tasks. In France these were more than 700 differ-

ent trade proficiency certificates in 1962, 250 under national curricular and 468 under programmes prepared at the departmental level to meet the local needs. The most elaborate system is that in Germany; an outline is drawn up for each recognized trade on the basis of which apprenticeship is organized. In 1962 there were 495 trades, excluding handicraft trades, 346 of which required an apprenticeship of 3-1/2 years and 138 an apprenticeship for one or two years.

In developed countries, more often than not the machine has assumed most of the skill requirements of the job, and the production systems are easier to run and required less skilled labour than before. In several instances a primary motive for automation was in fact to create jobs so simple and easy that less skilled labour could man them. Automation does not do away with the need for the semiskilled worker, it changes the pattern. In their initial form, the mechanization and rationalization of work have led to the breakdown of jobs into practical repetitive elements which require only a rapid and limited training. With automation, the operative becomes the controller, the regular of complex machinery, often of considerable dimension. Such functions, no doubt do not call for the technical knowledge or manual dexterity, slight as they already are, of the traditional semiskilled worker. But in attention and mishandling you may have much more serious consequences than bad workmanship on ordinary work in the form of stoppages, abnormal wear and poor output etc. The functions are therefore responsible ones, and require aptitudes and knowledge, ordinarily quite different from those needed for mass production in manual assembly line operations.

While technical progress calls for a rise in the general level of trade skill, it increases the uncertainty about what type of skill is needed. Materials used, equipment, production methods are changing more frequently and radically too. Acquired

knowledge, attitudes and tricks of trade are fast becoming out-dated. In view of this it is felt that the training schemes of the technicians should be broad based. Some of the reasons against narrow specialization are the following:

- i) In the Indian context narrow specialization will severely restrict the employment opportunities and mobility of technicians.
- ii) Narrow specialization may restrict future occupations advancement for want of higher level positions in many of the specialized fields.
- iii) In absence of a broad based technical knowledge, the scope for further study and adaptability to technological changes will be limited.

Limited facilities exist for training technicians in areas of glass, ceramic and vacuum technology. There is a dearth of tool engineers and technicians. To ensure adequate progress in the electromechanical areas like line printers, discdrives, the training of such personnel should be taken up on priority basis. In view of the development of TV broadcasting (terrestrial and satellite) there is a need for a large number of TV technicians.

During the formulation of the curriculum for training courses in engineering and technology, active participation from the industries was desirable. Frequent dialogue between the industry and educational institutions will help in providing the trained manpower of desired quality. In-plant training is as important as the theoretical course work in the training programmes. At present it is not being sufficiently emphasized in

the majority of the institutions.

In order to have properly qualified personnel to teach the advanced courses and overcome the obsolescence, that is inevitable in the field of electronics, it is suggested that short-term courses in specified advanced modern topics be organized by institutions which have the facilities for this purpose.

9.8 Training-in-Industry

The productivity depends on the type of training imparted to the personnel and its relevance to operational problems. Industrial and academic cooperation is vital for achieving the goal of economic well being. The alternatives to achieve this are as follows:

- i) Moving towards higher standards in education in relation to the actual professional needs, or
- ii) Adopting training-in-industry programmes.

The former alternative is beset with difficulties in view of the fast changing techniques of industrial operations. The training-in-industry would be mainly in instruction in techniques whereby scientific methods and empirical approaches are all used in the solution of operation, design and manufacturing problems.

Sandwich Courses

Another form of technical education is one where college education and industrial training are alternated with sufficient periods in each of them. This form of education is known as the sandwich system in England and cooperative engineering education

in the U.S. In Germany for the education of a technician the system of 12 months of industry plus 36 months of college plus 12 months of industry is followed. This system can be adopted preferably where the industries are well developed. A system with alternate layers of 6 months each in college and industry is being followed in the U.K.

In India such courses have not picked up. In view of the successful experience of other countries these may be started on an experimental basis.

With a view of meeting the diversified needs of the changing spectrum of industrial occupations, supplemental training in certain trades requiring polyvalent skills is required to optimize the utilization of labour. In view of this the Ministry of Labour plans to designate some selected ITI's as captive training institutes and reorient them to meet the requirements of specific industries in their neighbourhood.

The economic progress of a country is intimately linked with the industrial development. Development includes, besides research, the diversification of the industrial products. Technical education has an important role to play if the supply of suitably trained personnel is to be ensured. However, more is required from the technical education than producing managers, scientists, engineers, technologists and skilled workers. Qualities like leadership, initiative, cooperation and self-motivation are desirable in this personnel.

9.9 Reversing the Brain Drain

A scheme is being drawn up by the Department of Electronics for the return of Indian scientists and engineers in the elec-

tronics and allied fields from abroad. As on June 1973, there were 18,913 personnel enrolled in the "Indian Abroad" section of "National Register of Scientific and Technical Personnel", of these 39% were engineers, and 33% scientists, 21% medical personnel, and 7% technologists. About 50% of the total have already returned. Of the remaining, nearly 1,760 are either mechanical, electrical or electronics communication engineers and 600 are physicists. Particular attention is being paid to the **peculiar problems** of these engineering/scientific/technical personnel in various organizations in India. The main thrust of the present programme would be on getting professional men who are at present at the intermediate level and are deemed to be intrinsically of higher quality in their profession. These persons who are capable of acting as nucleating centres for the development of selected areas of electronics, shall be carefully identified. In view of the paucity of suitable placement opportunities for such persons in existing programmes in institutions/organizations, there have been difficulties in the past in getting this proposal to a practical start. With the formulation of the Fifth Five-Year Plan in electronics and telecommunications, many new programmes will be taken up in the existing industries/organizations and many new industries/organizations will be started both by the Department of Electronics and by other governmental and non-governmental organizations. It should then be possible to bring in suitable qualified persons from abroad and provide them the right kind of areas of work and working environments to enable them to accomplish time-bound tasks.

An important avenue for bringing in Indian scientists/engineers from abroad would be the production of technocrat entrepreneurship. There are many highly qualified persons who would like to come back to India to start their own industries. They would have to be provided with information regarding areas

in which scope exists for the starting of new industries and the relevant information on the various procedures that are involved in the initiation of new industries.

TABLE 9.1

ESTIMATED ADDITIONAL (DIRECT) MANPOWER REQUIRED DURING
THE FIFTH FIVE-YEAR PLAN (1974-79)

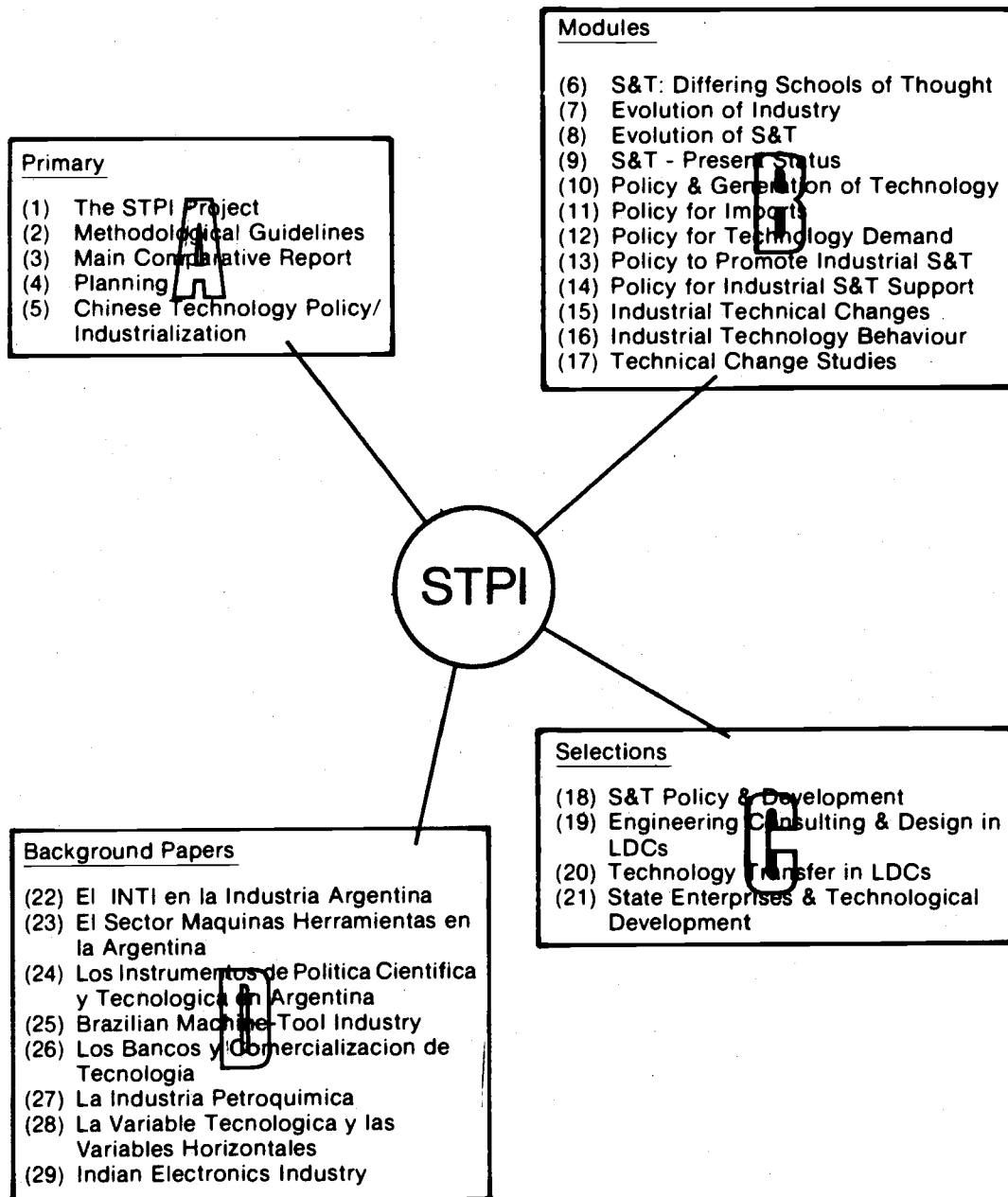
Sector	Scientists/ Engineers	Skilled	Semi- skilled	Un- skilled	Admin- istrative	Total	Percent Of Total
Consumer Electronics	1,000	2,000	15,000	2,000	2,500	22,500	12
Instruments & Medical Electronics Equipment	1,000	1,000	13,000	3,000	1,500	19,500	10
Computers & Desk Calculators	1,000	1,000	4,000	500	500	7,000	4
Control & Industrial Electronics	1,000	1,500	6,000	1,000	1,000	10,500	6
Telecommunication, tele- metry, Two-Way Communica- tion, Civil Navigation & Mass Communication	5,000	9,000	30,000	4,000	4,000	52,000	28
Components & Materials	3,500	6,000	42,000	8,000	4,500	64,000	35
General Facilities	2,000	4,000	1,000	1,000	2,000	10,000	5
TOTAL	14,500	24,500	111,000	19,500	16,000	185,500	
Percent of Total	8	13	60	10	9		

TABLE 9.2

ESTIMATED ADDITIONAL (DIRECT) MANPOWER REQUIRED DURING
THE SIXTH FIVE-YEAR PLAN (1979-84)

Sector	Scientists/ Engineers	Skilled	Semi- skilled	Un- skilled	Admin- istrative	Total	Percent of Total
Consumer Electronics	1,000	2,000	12,000	2,000	3,000	20,000	9
Instruments & Medical Electronics Equipment	1,500	1,500	14,000	3,000	3,000	23,000	11
Computers & Desk Calculators	2,000	2,000	6,000	5,500	1,000	11,500	5
Control & Industrial Electronics	1,000	2,500	7,500	1,000	1,000	13,000	6
Telecommunication, Tele- metry, Two-Way Communica- tion Civil Navigation & Mass Communication	6,000	12,000	33,000	6,000	7,000	64,000	30
Components & Materials	4,000	7,000	45,000	7,000	6,000	69,000	32
General Facilities	3,000	6,000	2,000	1,000	2,000	14,000	7
TOTAL	18,500	33,000	119,500	20,500	23,000	214,500	
PERCENT OF TOTAL	9	15	56	9	11		

Key to STPI Publications



**A GUIDE TO THE
SCIENCE AND TECHNOLOGY POLICY INSTRUMENTS
(STPI) PUBLICATIONS**

A. Primary Publications

- (1) The Science and Technology Policy Instruments (STPI) Project (IDRC-050e) (out of print)
- (2) Science and Technology Policy Implementation in Less-Developed Countries: Methodological Guidelines for the STPI Project (IDRC-067e) (out of print)
- (3) Science and Technology for Development: Main Comparative Report of the STPI Project (IDRC-109e). (Also available in French (IDRC-109f) and Spanish (IDRC-109s).)
- (4) Science and Technology for Development: Planning in STPI Countries (IDRC-133e)
- (5) Science and Technology for Development: Technology Policy and Industrialization in the People's Republic of China (IDRC-130e)

B. Modules

These constitute the third part of (3) above and provide supporting material for the findings described and the assertions made in (3).

- (6) STPI Module 1: A Review of Schools of Thought on Science, Technology, Development, and Technical Change (IDRC-TS18e)
- (7) STPI Module 2: The Evolution of Industry in STPI Countries (IDRC-TS19e)
- (8) STPI Module 3: The Evolution of Science and Technology in STPI Countries (IDRC-TS20e)
- (9) STPI Module 4: The Present Situation of Science and Technology in the STPI Countries (IDRC-TS22e)
- (10) STPI Module 5: Policy Instruments to Build up an Infrastructure for the Generation of Technology (IDRC-TS26e)
- (11) STPI Module 6: Policy Instruments for the Regulation of Technology Imports (IDRC-TS33e)
- (12) STPI Module 7: Policy Instruments to Define the Pattern of Demand for Technology (IDRC-TS27e)
- (13) STPI Module 8: Policy Instruments to Promote the Performance of S and T Activities in Industrial Enterprises (IDRC-TS28e)
- (14) STPI Module 9: Policy Instruments for the Support of Industrial Science and Technology Activities (IDRC-TS29e)
- (15) STPI Module 10: Technical Changes in Industrial Branches (IDRC-TS31e)
- (16) STPI Module 11: Technology Behaviour of Industrial Enterprises (IDRC-TS32e)
- (17) STPI Module 12: Case Studies on Technical Change (IDRC-TS34e)

C. Selections

These are a selection of the numerous reports prepared for the STPI Project chosen as a representative sample of the various topics covered by the STPI Project in the course of the main research effort on policy design and implementation.

Science and Technology for Development: A Selection of Background Papers for the Main Comparative Report.

- (18) Part A: Science and Technology Policy and Development (IDRC-MR21)
- (19) Part B: Consulting and Design Engineering Capabilities in Developing Countries (IDRC-MR22)
- (20) Part C: Technology Transfer in Developing Countries (IDRC-MR23)
- (21) Part D: State Enterprises and Technological Development (IDRC-MR24)

D. Background Papers

- (22) El INTI y el Desarrollo Tecnológico en la Industria Argentina (IDRC-MR34s)
- (23) El Sector Maquinas Herramientas en la Argentina (IDRC-MR35s)
- (24) Los Instrumentos de Política Científica y Tecnológica en Argentina (IDRC-MR36s)
- (25) The Brazilian Machine-Tool Industry: Patterns of Technological Transfer and the Role of the Government (IDRC-MR37e)
- (26) Rol de los Bancos en la Comercialización de Tecnología (IDRC-MR38s)
- (27) Comportamiento Tecnológico de las Empresas Mixtas en la Industria Petroquímica (IDRC-MR39s)
- (28) Interrelación Entre la Variable Tecnológica y las Variables Horizontales: Comercio Exterior, Financiamiento e Inversión (IDRC-MR40s)
- (29) A Planned Approach for the Growth of the Electronics Industry — A Case Study for India (IDRC-MR41e)