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STATE-OF-THE-ART SERIES ON MICROELECTRONICS

No. 5: BANGLADESH\*

Prepared for the Technology Programme

by

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EXPLANATORY NOTES

Abbreviations

CAD	Computer Aided Design
CAM	Computer Aided Manufacture
IC	Integrated Circuits
ISD	International Subscriber Dialling
NWD	Nation-Wide Dialling

Organizations

AEU	Asia Electronics Union
BUET	Bangladesh University of Engineering and Technology
ESCAP	Economic and Social Commission for Asia and the Pacific
IBA	Institute of Business Administration
ILO	International Labour Office
JICA	Japan International Co-operation Agency
OIC	Organization of Islamic Conference
UGG	University Grants Commission
UNESCO	United Nations Educational, Scientific and Cultural Organization
WGTT	Working Group for Technology Transfer

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### SUMMARY

The study reviews the state of the art and anticipated future developments of the Bangladesh microelectronics industry as well as research undertaken.

In the main subsectors of microelectronics industry, Bangladesh is still at the assembly stage of consumer electronic products using imported components. There are mainly TV sets, radio receivers and radio cassette recorders for the domestic market. Only five companies are actually dependent on technical collaboration agreements with foreign companies. There is no manufacture of any of the basic components in the country. Bangladesh has as yet limited experience of microelectronic applications. The users are largely in the public services area.

National R and D in the field is carried out by university departments and two national institutes. Especially the Institute of Electronics and Material Science has developed research activities. The University of Dhaka has initiated a scheme for the creation of an Institute of Silicon Technology.

Regional and international co-operation is essential for expansion of manpower training and R and D facilities through sharing of the available facilities in Japan and India under bilateral Science and Technology Agreements entered into with these countries. Assistance of United Nations agencies will go a long way in the promotion of manpower training and technology transfer.

# A STUDY ON MICROELECTRONICS INDUSTRY IN BANGLADESH

## CHAPTER - 1

### Introduction

#### 1. The nature of the study:

1.1 The United Nations Industrial Development Organization (UNIDO) co-sponsored an international Symposium on "Electronics for Productivity" along with the Asia Electronics Union (AEU), Japan, in New Delhi on April 21-23, 1983. The symposium was organized by the Electronics Commission (IPAG) of the Government of India. Apart from the central theme of the seminar as stated above, two special sessions were earmarked for deliberations on technology transfer. One such session was chaired by the Consultant in his capacity as Chairman of the Working Group for Technology Transfer (WGTT) formed in the 7th General Assembly of the AEU in December 1981 in Bangkok.

#### 1.2. Background:

One of the recommendations of the Symposium was related to the setting up of an "Asian Centre for Electronics", and to requesting UNIDO to take appropriate action in this regard. In this context UNIDO observed, as follows, in the cable addressed to the Consultant inviting him to undertake a national study for Bangladesh.

" Having considered alternative proposals for moving in this matter and in view of request to UNIDO also for setting up the international centre for microprocessor applications, we have come to the conclusion that the starting point towards the implementation of the New Delhi recommendations will be to study the state of the art in electronics, in selected developing countries, including some in the Asian region. These studies, besides focusing on the actual situation, will be required to highlight the areas in which the country needs regional and international co-operation and the areas in which it could contribute its own facilities and expertise to such co-operation" .

1.3 Terms of Reference:

A summary of the points highlighted in the terms of references is given below:

- (i) (a) Governments's technology strategy and policies in microelectronics, i.e. manufacture and application of integrated circuits (ICs) in consumer electronics, industrial controls and applications, telecommunications and special techniques, such as computer-aided-design (CAD), computer-aided manufacture (CAM) and computer-integrated-manufacture (CIM);
  - (b) Need for national policies and strategies and the scope of assistance that UNIDO could render in this regard, with special reference to promotion of regional/international mechanisms and programmes;
  - (c) National policies to cover a wide area, e.g. public awareness campaign, concentrated programme for education and training, support for manufacture of electronic components, public procurement policies, research and development;
  - (d) International/regional co-operation possible in early identification and assessment of technological advances in microelectronics; establishment of plants for the design and production of microelectronic components and interface elements; identification of application possibilities in critical and priority sectors relating to domestic and external markets; specialized "centres of excellence" to promote and carry out R and D and applications; conduct of feasibility studies; exchange of information and co-operation in regard to public purchases; socio-economic assessment of the impact of the technology;
- (ii) National R and D;
  - (iii) Acquisition of microelectronics technology;



- (iv) Main foreign suppliers of this technology and equipments;
- (v) Raw-materials and existing infrastructure for microelectronics development;
- (vi) Manpower problems in microelectronics industry and training efforts; reversal of brain drain;
- (vii) Scope of introduction of different stages of manufacture of silicon chips;
- (viii) Availability of facilities for maintenance and repair of equipment and spares;
- (ix) Main fields of application of microelectronics equipment, including computers;
- (x) Acquisition and development of computer software.

1.4. The scope:

The scope of the study is obviously related to development of microelectronics industry and application of ICs. But in the course of the study, one has to cover areas extending to development of electronics as a whole. The socio-economic aspects of the study is also quite significant in the wake of rapid technology advances in electronics.

CHAPTER - 2

APPROACH AND METHODOLOGY

2. Approach:

2.1 In the absence of any reliable national statistics on the growth of microelectronics industry and related issues as per terms of reference, it was considered appropriate to undertake field investigations in selected industrial units where application of micro lectronics exists and for this purpose, a proforma was designed to get the required information incorporated therein. It was also felt necessary to interview heads of Government ministries and departments, semi-Government or autonomous corporations or agencies, educational institutions, training institutes, etc. to elicit the requisite information to make the study comprehensive.

2.2.1 Methodology and design:

The industry study proposed to generate, among other things, data/information on the following items:

- (i) the different types of electronics products of the industrial units using ICs and year-wise production of these products;
- (ii) whether the company is in the public or private sector or a foreign-owned or joint-venture unit;
- (iii) future plan of expansion and R and D;
- (iv) availability of servicing facilities and spares.

2.2.2 Interviews with two Ministers and the heads or persons designated by the heads of relevant ministries, departments, educational institutions, autonomous or semi-autonomous corporations, specialized institutes or offices concerned with electronics/microelectronics in someway or other were taken covering the points mentioned below:

- (a) Governments technology strategy and respective policies in the field;
- (b) National R and D in the field: prospects of regional co-operation;
- (c) National approach towards acquisition of microelectronics technology;
- (d) Main foreign suppliers of microelectronics technology and equipment, with special attention to regional resources;
- (e) Main fields of application of microelectronics equipment purchased locally and bought from within as well as outside the region;
- (f) Raw materials and existing infrastructure for microelectronics development;
- (g) Manpower problems in microelectronics industry and training efforts undertaken (e.g. by suppliers of technology and by local institutions and enterprises);
- (h) Main areas in which the country needs co-operation and can offer co-operation at the regional and international levels;
- (i) Scope of introduction of different stages of manufacture of components including custom-designed chips and applications thereof;
- (j) Availability of facilities for maintenance and replacement of spare parts.

### 2.3 Field study:

In Bangladesh 39 units are engaged in manufacturing television, radio-receivers and radio-cassette-recorders, etc. Of them 33 units are manufacturing only radio-receivers or radio-cassette recorder or both. Besides, another joint-venture company is manufacturing products using ICs. Of these companies, seven units using ICs were selected for in-depth on-the-spot study for the present purpose.

### 2.4 Interviews:

In all 30 persons, representing a cross-section of the people involved in one way or the other with the development of electronics in Bangladesh, were interviewed to elicit a variety of information and views.

CHAPTER - 3

REVIEW OF PRESENT SITUATION

3. The State of the Art :

The electronic industry made a start in Bangladesh in the early 1950s with the setting up of a few assembly plants for producing a limited range of radio sets. In the 1960s more assembly units were added. With the introduction of television station in Dhaka in December 1964, some of these units also started manufacturing television sets. At present i.e. upto the end of the year 1983, six companies including one TNC and two public sector enterprises are manufacturing Black & White television sets of different sizes ranging from 24" screen size to 12" screen size and only two of these companies including one in the private sector are making colour television sets also.

3.1 In addition to the companies mentioned above, 13 other companies have also received Government sanction for the manufacture of B/W and colour television, but they are not in production. As regards units sanctioned for manufacture of radio-receivers and radio-cassette-recorders, it appears that as many as 40 companies received sanction of the Government for manufacture of these products. But actually all of these units are not in production. One local company, however, has entered into a joint-venture with a Swedish firm manufacturing automatic electronic fences and battery chargers, exclusively for export on a sub-contracting basis. This company is also manufacturing Printed Circuit Boards and dry-type transformers for use in their electronic circuits.

3.2 Existing application of microelectronics:

The use of microelectronics in Bangladesh has been growing steadily in consumer electronics manufactured in the country, such as, radio receivers, television, radio-cassette-recorders, etc. The electronic industries in Bangladesh is now mostly limited to assembly operation on the basis of import of basic components in CKD condition from abroad.

3.2.1 As yet there is no manufacture of any of the basic components in the country in the public or private sector, including the transnational company which has now been operating for a long time. The companies which are making the above-mentioned consumer electronic goods in the country using imported microelectronics are six in number. In course of field enquiries, it transpired that one of the seven companies visited was not using microelectronics in its manufacturing process, while another furnished incomplete information about its IC use.

3.2.2 Of the units which are actually using ICs at the moment, three are functioning with technical collaboration agreement with reputed foreign companies and two of them are Japan-based. Another company which has recently started manufacturing television and radio-receivers is in technical collaboration with a Thai company. Table 1 below shows sectorwise distribution of these companies. The annual figures for the production of television, radio and other items and the use of ICs in their manufacturing process are given in Table 4 (page 9).

Table 1 : Type of company (ownership)

Ownership	Public	Private	Total
Bangladeshi	2	3	5
Joint-venture	-	2	2
Total	2	5	7

Remarks : All the three companies in private sector have technical collaboration with foreign companies.

3.2.3 The professional equipments used in public telecommunication, communication and navigation equipments of aircrafts, civil aviation facilities of Dhaka International Airport and domestic airports, meteorological departments, armed forces, television station, research institutes, etc. have a wide range of IC application.

The main professional equipments using ICs in a number of selected organisations are listed in Table 2 as under.

Table 2

<u>Name of organization.</u>	<u>Equipments using ICs</u>
Bangladesh Telegraph and Telephone Board	Trunk Automatic Exchanges for Nationwide Dialling, International Subscriber Dialling Exchange, Telex Exchange, Carrier Multiplex.

Civil Aviation Authority	Radio chain communication, Teleprinter, Instrument Landing System Localiser, TV Monitor, Microcomputer.
Biman (Bangladesh Airlines)	All communications and navigation equipments used in F-28 and DC 10-30C aircrafts.
Meteorological Department	Weather Rader, Automatic Weather Observing System, Rawinsonde, Communication Equipment.
Bangladesh Television	Production Video Switches, Transmission Control Circuits.

3.3 Allocation of funds :

The Revised Industrial Investment Schedule published by the Department of Industries of the Bangladesh Government for the last 3 years of the Second Five-Year Plan period (July, 1982-June, 1985) for private sector indicates an allocation of Tk. 45 million (inclusive of 50% foreign exchange) in respect of radio-receivers and Tk. 60 million (inclusive of 30% foreign exchange) in respect of B/W and colour television sets. So far as the utilization of this allocation is concerned 98% (approx.) of the fund allocated for the television sector has been sanctioned, whereas a sizeable amount allocated for radio-receivers has been reported to be exhausted. It is, however, to be noted that quite a few of the sanctioned units, both in the television and radio sectors, have not yet gone into production (vide Table 3 below)

Table - 3

Electronic industrial units and total investment sanctioned in Industrial Investment schedule (1982-85)

Name of product	Sanctioned units		Total allocation (1982-85)
	Total No.	No. in production	
Television	13	6	60 million (local currency: 42.0 million plus foreign exchange: 18.0 million)
Radio-receivers, radio-cassette recorders, etc.	40	33	45 million (local currency: 22.25 million plus foreign exchange: 22.25 million)
Computer servicing and maintenance	1	Recently sanctioned	3.16 million (local currency: .93 million plus foreign exchange: 2.23 million)

Source: Interview of officers of the Industries Department, Government of Bangladesh. (Appendix - IVA)

**Table-4**

**Companywise annual production of TV, Radio & others and use of IG by the Companies.**

**No. of Companies using IGs: 5**

Year	Television					Colour			Radio	Others	Total use of IG	Annual rate of increase of IG used ( % ) (1)
	B/W		Company C	Company D	Total	Company B	Company C	Total	Company C	Company E		
	Company A	Company B										
1977	6,000	-	-	-	6,000	-	-	-	-	-	12,000	
1978	7,500	480	-	-	7,980	-	-	-	-	-	16,920	41
1979	7,000	502	3,000	-	10,502	-	-	-	-	-	19,008	12
1980	8,000	981	3,000	12,000	23,761	-	-	-	-	-	70,044	269
1981	10,000	1,737	3,000	15,000	29,737	-	-	-	-	-	89,948	28
1982	8,500	1,460	3,000	15,000	27,960	107	500	607	10,000	10,000	125,982	40
1983	8,500	1,612	3,000	18,000	31,112	145	-	145	10,000	30,000	156,318	24
<b>Total</b>	<b>55,500</b>	<b>8,352</b>	<b>18,000</b>	<b>60,000</b>	<b>137,052</b>	<b>252</b>	<b>500</b>	<b>752</b>	<b>20,000</b>	<b>40,000</b>	<b>490,220</b>	<b>38 (2)</b>

N.B: (1) The annual rate of increase has been determined taking the preceding year as base.

(2) Overall annual rate of increase.

3.4 Future plan of expansion :

3.4.1 It is evident that there is a trend of increasing growth in the use of microelectronics by way of expansion of electronic industries like manufacturing television, radio-receivers, etc.

Another thrust in this growth is likely to come when the Government implements its policy of switching over its local telephone exchanges to digital and manufacturing the same in phases in the country.

3.4.2 Further expansion in the use of microelectronics is expected with increasing computerisation in the Government departments/ agencies and commercial offices, including banks and insurance companies, in pursuance of a recent policy decision taken in this regard.



CHAPTER - 4

MANPOWER TRAINING AND R & D

4. Existing facilities :

4.01 Bangladesh has a large labour force consisting of about 27 million workers (1980), with a net addition of about 0.9 million workers to this labour force every year. (vide 1982 statistical yearbook of Bangladesh, page 163). Annual manpower output of educational and training institutions in the country was 540 engineers (including 45 in electronics) and 4140 technicians in 1978 and 4148 trade and craft workers (including 46 in electronics) in 1980. (Source: Table III, page 170 of the Report on Regional Study of the Electronics Industry, ESCAP (RCIT), August, 1981.

4.01.1 The existing training facilities in manpower development are briefly described below:

- (a) At the technician and supervisor's level, one can be admitted in any of the two Polytechnic Institutes at Dhaka and Chittagong where a Diploma course on electronics up to a certain level is offered. For admission in any such Institute, a Secondary School Examination Certificate is the requisite qualification;
- (b) Under the auspices of the Organisation of Islamic Conference (OIC), an Islamic Centre for Technical and Vocational Training and Research is being set up in Dhaka for imparting technician-level training in various trade crafts, including electronics, to students of Islamic countries. The centre has also a programme of imparting training to teachers. The intake of trainees is expected to start within a year or so.
- (c) Two training centres, one at Dhaka and another at Khulna on telecommunication, including basic electronics course, are functioning for a one-year training to departmental personnel upto technician and supervisor level. About 600 departmental technicians and supervisors are being trained

in these centres annually. Around 50 graduate engineers are also being trained every year in these centres. From 1985, a Telecommunication Staff College for providing training to about 300 graduate engineers is being contemplated.

- (d) Short-term trade-courses for one year or so in the two Polytechnic Institutes mentioned above and a Government Technical Training Centre at Dhaka are also available to qualify students to work merely as a semi-skilled worker in TV or radio assembly plants or repair-cum-servicing workshops for electronic appliances.
- (e) Training at the professional level is conducted through the different Degree courses at all the four general universities, including the three engineering Degree colleges in the country and in the Bangladesh University of Engineering & Technology (BUET), Dhaka. Microelectronics is included both in the lecture and laboratory courses leading to the B.Sc.(Engineering), B.Sc.(Hons.) and M.Sc.in Applied Physics and Electronics. In addition, post-graduate courses on computer science and software are offered in the new Department of Computer Science and Engineering under BUET.
- (f) A one-year certificate course on service and maintenance of scientific instruments, including microelectronics, is conducted by the Institute of Scientific Instrumentation under the University Grants Commission (UGC) at Dhaka. In addition, general and on-the-job training of the personnel specific to the requirement of equipments are provided by the Civil Aviation Authority, Biman (Bangladesh Airlines), etc.
- (g) Besides regular training programmes, special short courses related to microelectronics are given at the Computer Centre of the Bangladesh University of Engineering and Technology (BUET), Department of Applied Physics and Electronics, University of Dhaka, Institute of Scientific Instrumentation and the Telecommunication Training Centres referred to above. Some training in computer

software is also provided at the above mentioned Computer Centre and special courses on computer software are undertaken by the Institute of Business Administration (IBA), Dhaka.

- (h) In addition, a number of private companies claim to have arrangements for providing technician level training in electronics and also training courses in high level computer languages. However, it is generally felt that due to rapid technological development in professional equipments, continuous refresher training at supervisor's level is definitely required in order to keep the knowledge of these personnel updated.

#### 4.2 Research and development :

4.2.1 Some research and development in the use of microelectronics are being carried out at the Department of Electrical and Electronic Engineering, and Department of Computer Science and Engineering of the Bangladesh University of Engineering and Technology (BUET), Department of Physics and Department of Applied Physics and Electronics of the University of Dhaka Institute of Electronics and Material Science and Electronics Division of the Atomic Energy Centre of Bangladesh Atomic Energy Commission, Dhaka.

4.2.2 The ambitious programmes of the Institute of Electronics and Material Science, located in the outskirts of Dhaka needs special mention. Its broad objectives are :

- (1) Promotion of R & D in electronics;
- (2) Providing electronic installation, testing, servicing, quality assurance (QA) and quality centre(QC) needs;
- (3) Training of electronic personnel; and
- (4) Small-scale fabrication of electronic equipments.

4.2.2 In addition to activities of the Institute of Electronics and Material Science, the Electronics Laboratory of the Bangladesh Atomic Energy Centre has completed quite a few R and D projects in material science, while some more are in progress.

CHAPTER - 5

FINDINGS

5. Points emerging from the study :

5.1 It was clear in course of the study that the present status of electronics industry in Bangladesh is related mainly to assembly operations in television, radio receivers, radio-cassette-recorders, etc. for domestic consumption only.

5.1.1 At the same time, it was found that the use of IC application is steadily growing in the above assembly operations. But upto now, no positive effort has been made for local manufacture of microelectronics, partly because the domestic market is limited and partly because of want of technology.

5.1.2 No project has yet been undertaken either in the public or private sector for manufacture of any basic electronic component. However, there is a general awareness about the need for making a start in the matter of manufacture of basic components for import substitution and acquisition of technology. This will be apparent from the step taken by the Government of Bangladesh about a year back in forming a Working Committee under the Industries Division for studying the existing situation and recommending appropriate action to be taken in this regard. The Consultant served on this Committee and its report is now under active consideration of the Government.

5.1.3 Existing facilities available on national basis for manpower training is not obviously enough at technician or supervisory level. The engineers and scientists who are coming out of the general universities and the University of Engineering & Technology are not getting attractive employment at home and the net result is that there is a constant brain drain from the country.

5.1.4 Activities in Research and Development are also limited. The existing Institute of Electronics and Material Science set up under the Bangladesh Atomic Energy Commission is not equipped to meet the national

needs. Nor are the scope of R & D facilities existing in the general universities and the Bangladesh University of Engineering and Technology (BUET) sufficient for the country as a whole. It is, however, noteworthy here that a scheme has been initiated by the University of Dhaka for the creation of an Institute of Silicon Technology, which is obviously a step in the right direction.

5.1.5 The Government of Bangladesh has not yet defined its technology strategy and policies in the development of electronics industry. Uptil now, the practice of technology import is being followed in the projects so far implemented with wide application of microelectronics e.g. International Subscriber Dialing (ISD) and Nation-Wide Dialing (NWD) manufactured by NEC, Japan. They are the main foreign suppliers of microelectronics technology and equipment in the country.

#### 5.2 National policy and strategy : steps already taken

In the absence of any national policy or a sense of direction, the development of microelectronics industry has not naturally made any headway. In 1981, a National Symposium on Electronics was held at Dhaka. This symposium made useful recommendations in the matter of development of electronics, including microelectronics, manpower training and R & D in the country. Government of Bangladesh has recently constituted a National Committee on Science & Technology at the highest level with well-defined guidelines for framing a national policy and strategy in different technological fields. There is a recommendation of the Science & Technology Division for the formation of a sub-Committee or task force to draw up national policy guidelines and strategy in the field of electronics development for consideration by the National Committee on Science and Technology (NCST). In addition to this, a National Computer Committee (NCC) has also been constituted by the Government to formulate appropriate strategy and policy guidelines for development of computer technology, identification of application areas and fixation of priorities and frame an action plan for developing necessary trained manpower. The NCC is now engaged in collecting necessary information and data.

5.3 Potentialities for regional/international co-operation :

5.3.1 The scope of seeking assistance from international agencies or co-operation of any developed country in or outside the Asian region to make a feasibility study as to how to make a start in promoting microelectronics industry is undeniable. This is a very important step for which international or regional co-operation is essential. The establishment of a plant for manufacturing microelectronic components will come after asking for such co-operation.

5.3.2 In regard to manpower training and sharing of R & D facilities at regional level, need for inter-country or bilateral co-operation is also being keenly felt.

5.3.3 The favourable response noticeable in different quarters e.g. University of Dhaka Atomic Energy Commission and elsewhere to the question of establishing a regional centre or institute for electronics technology in Bangladesh has demonstrated the interest shown by concerned authorities to have an institute of this nature for the promotion of R & D, higher training and technology transfer.

CHAPTER - 6

COMMENTS

6. Promotion of microelectronics industry :

6.1 Electronics industry in Bangladesh is now related to assembly operations in some consumer electronic products for domestic market. There was a consensus among the persons interviewed in this study that steps should be taken as early as possible for the setting up of microelectronics industry in the country. It was also generally agreed that this has to be done in the private sector with arrangements for a joint-venture with reputed foreign companies. The objective will be not only import substitution and technology acquisition, but also export to other countries, which will provide the advantage of economies of scale.

6.1.1 A feasibility study should, of course, precede this step to identify the specific areas or processes for which such joint-venture projects should be desirable to satisfy the national objectives and priorities. To start with, an export-oriented undertaking on joint-venture basis could be launched to manufacture, for example, chips separation or I.C.-bonding, packaging and testing.

6.1.2 The above step is also sure to accelerate the transfer of technology. But a joint-venture effort will have meagre chance of success unless adequate incentives are provided for in the shape of:

- (a) directing development financing institutions to accord top-priority to this sub-sector of industry;
- (b) establishing an air-based export processing zone in the proximity of Dhaka Airport to attract export-oriented foreign investment to Bangladesh; and
- (c) providing attractive tax and fiscal concessions and other facilities.



6.2 National R & D :

6.2.1 The study has revealed the absence of sufficient R & D activities in the country. The first step which needs careful consideration in this context is to establish a National Institute of Electronics, by expanding the role and scope of the existing Institute of Electronics and Material Science now working under the Atomic Energy Commission, to gear up and co-ordinate R & D activities at national level, besides increasing the infra-structural capability.

6.2.2 In order to develop I.C. manufacturing technology, a multi-disciplinary approach will be useful involving chemists and metallurgists to develop raw-material, solid state physicists and electronic engineers to develop IC-design technology and applications. Sufficient fiscal incentives and appropriate foreign trade policy measures shall also be needed to develop microelectronics industry.

6.2.3 The Science and Technology Division of the Government is rightly considering a pragmatic step to set up a task force under the newly formed National Committee on Science & Technology to formulate a national policy and plan and identify the areas of R & D and other programme for development of electronic industry, including microelectronics.

6.3 Manpower training :

6.3.1 The need for intensifying efforts for manpower training in the framework of a national plan is a pressing one. It has been acknowledged that the existing facilities at Dhaka University, University of Engineering and Technology (HJET), Dhaka Polytechnic Institutes, departmental training centres of T & T Board, Biman, Bangladesh Television, etc. are not enough. With more emphasis being laid in future on the development of electronic industry as a whole, there will be even greater need for more professional scientists and engineers in this field. The present facilities in the Universities and other

educational institutes will then have to be strengthened and expanded. Moreover, an integrated approach for imparting intensive training at technicians and supervisors level is an urgent necessity.

6.3.2 This is also true of training needs for maintenance and servicing of electronic equipments. Two sources have mentioned that there are contracts with suppliers of the equipments for training, maintenance and supply of spares. These adhoc facilities are not considered sufficient. Of course, in the Institute of Scientific Instrumentation of UGC and the Electronics Division of the Dhaka Atomic Energy Centre (AEC), there are some facilities for maintenance of electronics equipments and it is reported that during 1981 to 1983, a large number of equipments were repaired in the Electronics Division of BAEC. In the private sector, an allocation of Taka (Tk.) 3.16 million (including foreign exchange of Tk. 2.23 million) has been provided for computer servicing and maintenance industry. Nevertheless, it is obvious that these facilities need expansion to meet the future needs of the country as a whole.

#### 6.4 Development of software :

6.4.1 As regards development of software, there is much to be desired. In the Computer Centre and the Department of Computer Science & Engineering of BUET, software has been developed for the following programmes:

- (i) 3-dimensional finite element analysis (linear and non-linear) in FORTRAN,
- (ii) ground water modelling in FORTRAN,
- (iii) analysis of transmission towers in FORTRAN, and
- (iv) load flow studies for the national power grid in FORTRAN.

6.4.2 The Institute of Business Administration (IBA), University of Dhaka also conducts occasional courses in the same line. However, one can safely conclude that these facilities for software development are insufficient not only to meet the demand at home but also for export to countries abroad where the requirement is already great and increasing fast in the wake of rapidly advancing computer technology.

6.5 Technology Transfer and Regional and International co-operation:

6.5.1 Technology transfer is a vast area for discussion. In the first place, it depends largely on the national strategy and priorities fixed for a country. The Consultant was associated with in-depth studies on the subject so far as it related to Asian region as Chairman of a Working Group for Technology Transfer formed by the Asian Electronics Union in its 7th General Assembly meeting in Bangkok in December, 1981. A report was prepared by him on the basis of presentations made by the delegates who participated in the International Symposium held in New Delhi in April, 1983. This report was presented at the 8th General Assembly of the Asia Electronics Union in Jakarta, October 21, 1983. It is worthwhile to quote the relevant portion from the proceedings of the 8th General Assembly, as follows :

"Five projects were proposed and elaborated in the report :

- (1) Establishment of the Asian Institute of Electronics Technology,
- (2) Promotion of sub-contracting from developed to developing countries,
- (3) Promotion of license agreements and joint venture projects,
- (4) Short country courses in developing countries,
- (5) Video training materials.

The assembly accepted the report of the WGT as a starting point towards the achievement of the objectives of the Union to be firmed up with further actions by the Union".

The idea of an Asian Institute for Electronics Technology to be set up in a developing country like Bangladesh evoked keen interest from responsible quarters in the country.

6.5.2 Bangladesh needs international and regional co-operation in various ways. Even a National Institute of Electronics might need international support in the supply of equipments and necessary funding. Apart from this, for expansion and strengthening of manpower training and R & D facilities, regional or international co-operation is essential. To cite an example, the Institute of Scientific Instrumentation has provisions for having instructors and equipments from U.K. through the good offices of the British Council. Such efforts should be made more comprehensive and sustained.

6.5.3 In the sphere of R & D, there is scope for Bangladesh to share the facilities available in India and Japan under the terms of the Scientific & Technological Agreements entered into between these countries and Bangladesh. In computer software technology, Japan International Co-operation Agency (JICA) acting on behalf of the Government of Japan is arranging a 3-month programme once or twice a year in collaboration with Asia Electronics Union for Asian member countries. Bangladesh should avail of these programmes every year.

6.5.4 In the field of education and training, assistance of UN agencies like UNESCO, UNIDO, ILO and ESCAP will go a long way in the promotion of manpower training and transfer of technology.

6.6 Brain-drain :

6.6.1 It is undeniable that there is a constant brain drain from the country, even though our professionally qualified scientists and engineers are not yet considered surplus. This phenomenon can perhaps be reversed if facilities exist in the country for proper application of the technology acquired by them and reasonably attractive salary

is offered to them. At the same time, it is felt that Bangladesh should become an active member of all regional and international fora devoted to the cause of microelectronics development and send competent representatives to participate in such fora.

CONCLUDING REMARKS

1. Bangladesh is now at the assembly base of consumer electronic products for domestic market. It is felt that steps for the setting up of microelectronics industry should be taken up in the country as early as possible. This should be a joint-venture industry with reputed foreign companies willing to invest and transfer technology.
2. A feasibility study should be undertaken first to identify areas or processes for which such joint-venture projects should be launched. To start with, any such joint-venture project should be export-oriented.
3. Adequate incentives are to be offered to attract foreign investment:
  - (a) by treating this sub-sector of industry on priority basis on the part of development financing institutions;
  - (b) by establishing an air-based export processing zone in Dhaka; and
  - (c) by offering large tax and fiscal concessions and other facilities.
4. A National Institute of Electronics should be set up by expanding the role and scope of the existing Institute of Electronics and Material Science of the Atomic Energy Commission for gearing up and co-ordinating R & D activities at national level.
5. A multi-disciplinary approach is essential for the development of microelectronics industry.
6. Early formulation of a national policy and plan for the development of electronics industry and manpower training is essential. Existing facilities in the country for manpower training have to be strengthened and expanded.
7. For maintenance and servicing of electronic equipment existing facilities are inadequate to meet the needs of the country. These facilities should be made more comprehensive.
8. For development of software, existing facilities are insufficient for the national need. Special attention is required to develop software for export to countries where computer software is in demand.

9. Transfer of technology to Bangladesh, which is one of the least developed countries, may take place in various ways. One of these ways would be to have an institute or centre for electronics technology established in the country through international co-operation on the lines proposed at the 8th General Assembly of the Asia Electronics Union in Jakarta, October 21, 1983.

10. Regional and international co-operation is essential for expansion of manpower training and R & D facilities through sharing of the available facilities in Japan and India under bilateral Science and Technology Agreements entered into with these countries. Assistance of United Nations agencies will go a long way in promotion of manpower training and technology transfer.

