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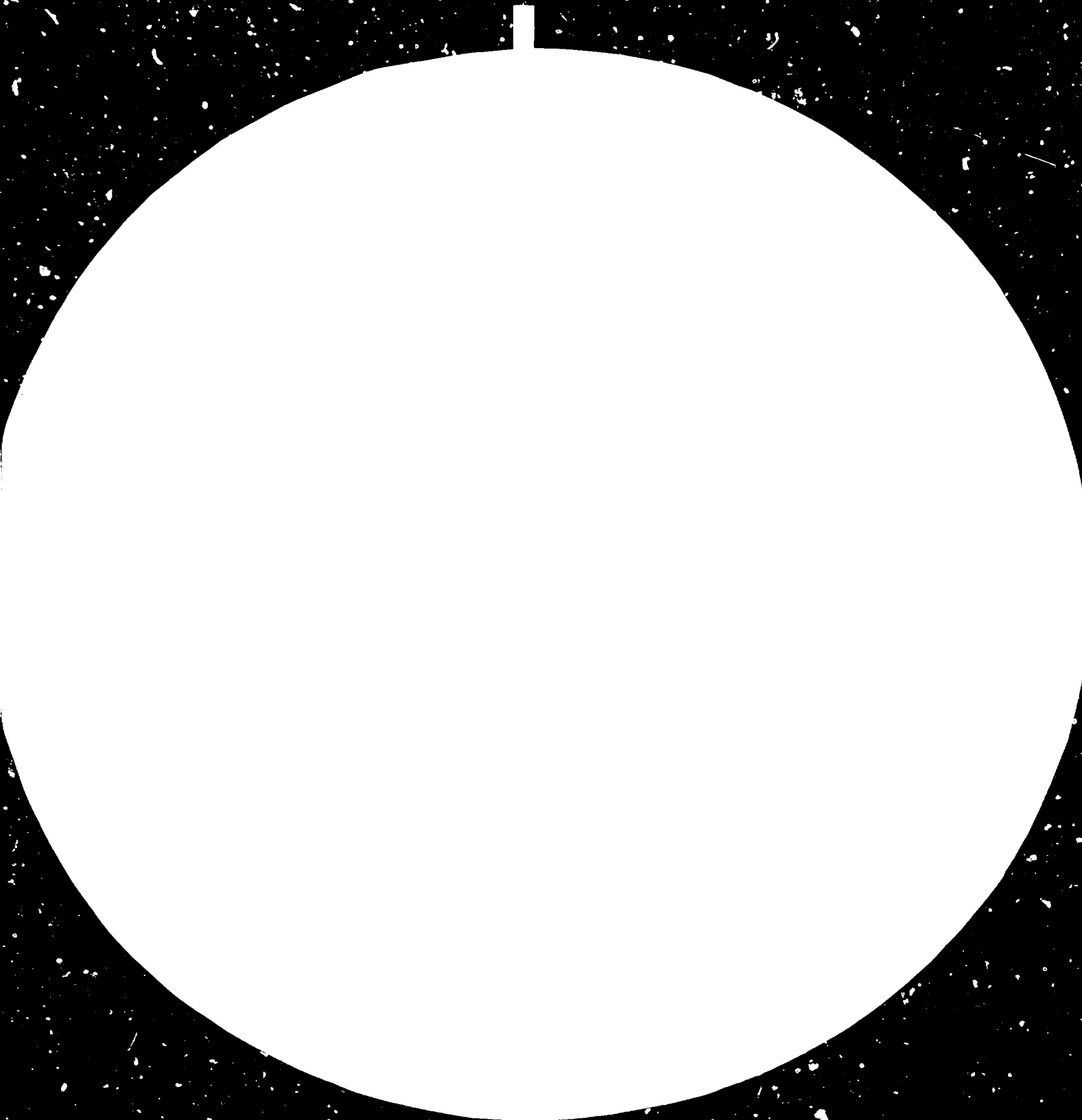
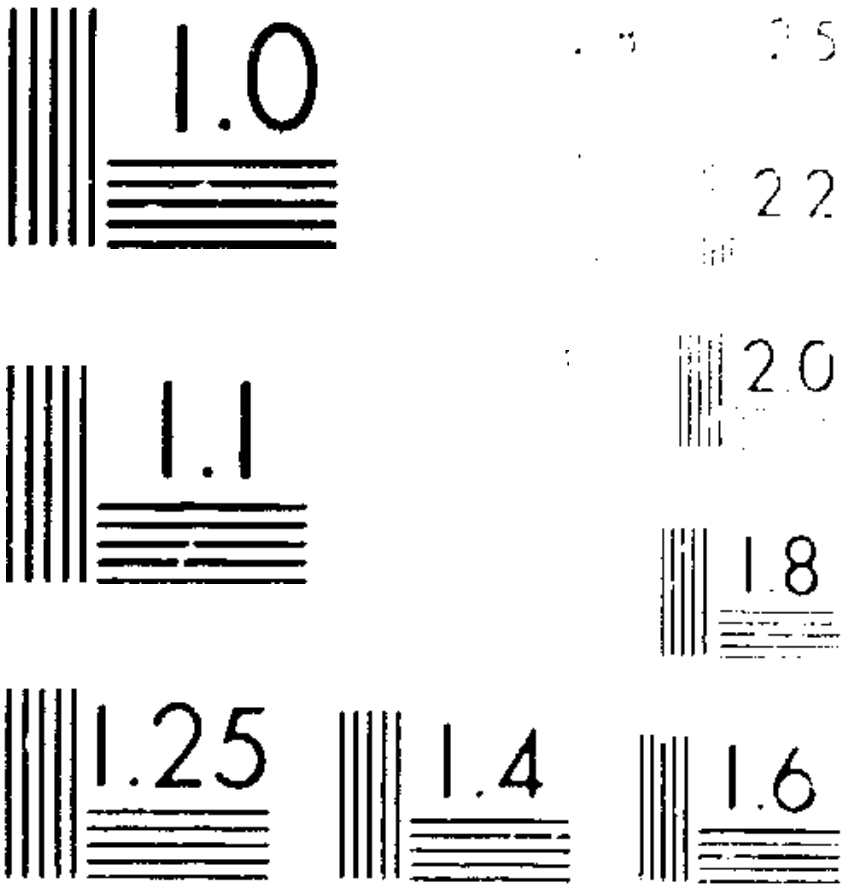
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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EXCHANGE OF VIEWS WITH EXPERTS
ON THE IMPLICATIONS OF TECHNOL-
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ELECTRONICS FOR DEVELOPING
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Vienna, 10-12 June 1981

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IMPLICATIONS OF MICRO-ELECTRONICS IN DEVELOPING COUNTRIES

by

Dr. Mohammad Aslam
National Institute of Electronics
Islamabad

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IMPLICATIONS OF MICRO-ELECTRONICS IN DEVELOPING COUNTRIES

BY

DR. MOHAMMAD ASLAM,
DIRECTOR NATIONAL INSTITUTE OF ELECTRONICS,
P.O. BOX 1406, ISLAMABAD.

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Dr. Mohammad Aslam,
Director, National Institute of Electronics,
P.O. Box 1406, Islamabad.

ABSTRACT

Considering the emergence of high technology in the electronics field an analysis has been made of the rapid changes in the field of micro-electronics. The advances in micro-electronics have already revolutionised the developed world in sophistication of electronic equipment and systems. The effect on developing countries becomes more pronounced as they mostly depend upon imported equipment.

Pakistan being a developing country, its case history is reviewed in the light of its requirement of electronic equipment, available resources (human and material), implications of micro-electronics on meeting its needs and finally suggesting ways and means for the developing countries as to how to cope with the implication of the ushering era of micro-electronics.

1. Introduction.

The use of Electronics in Radio, Television and Cinematography makes a tremendous impact on social, cultural,

political and economic life of a nation. Telecommunication made convenient with sophisticated, reliable and efficient electronics has eliminated the previously long delays in transfer of information from one place to another. The equipment for defence has been developed for proper surveillance, unbelievably accurate method of espionage, command control systems and intricate remote electronic triggering devices. The medical electronics has modernised the diagnosis of diseases and thereby making it possible for speedy treatment of the ailments, resulting in increased life expectancy. The detection of crime and the use of electronic traffic control allows right flow of traffic in big cities thus contributing towards better civil amenities. The introduction of process and quality control instruments has helped in increased production and reliability. The use of electronic computers and data handling systems has made a major contribution to the scientific research by solving problems of complex nature. These are only a few examples of the use of electronics for advancement of a society. The importance of electronic equipment usage in the process of socio-economic development of the country is universally recognized all over the world. It can surely be claimed that the growth of electronics activity in any country is a measure of economic growth of that country.

The rapid advances in technology have brought forth obsolescence in electronic components at an equal pace. The miniaturisation has added another dimension to the problems

being faced by developing countries. In order to be up-to-date in knowledge and technology acquisition the developing countries have to work hard.

2. Micro-Electronics.

The major break through in the electronics have ushered into the era of Micro-electronics. Starting from integrated circuits and going through the stages of small scale integration (SSI), large scale integration LSI and very large scale integration (VLSI) complete systems are available on single chips leading to 32 bit micro-processor providing a very powerful tool for various applications. The advances in memory technology especially the bubble memory has revolutionarized this technology. A storage capacity of 12 million bits of information and random excess memory of 2 mega bits have been realized. The technology is growing with such a rapid rate that the limits are almost being set by the base material. The research work for searching alternate base material such as Ga As, InP is already in progress and reasonable results have been achieved for quick response time, less power consumption and other benefits as compared to the silicon based material.

The charge coupled devices, Josephson's effect devices and super-conductors have added a new dimention in the development of electronics technology. In the near future the application of these devices will bring more advanced and sophisticated electronic instrumentation and circuits for

Fig.1 shows the US market's consumption alone for Integrated circuits and Data processing systems, as can be seen the market is expected to reach a U.S.$ 10 billion and $ 50 billion mark respectively by 1984. Of course these figures do not include the Japanese, Western European and other countries of world. Keeping the overall production in view these figures may rise to $ 20 billion and $ 80 billion respectively.

In 1981 forecast of the total US electronic equipment consumption is $ 168 billion so the two items given in Fig. 1 together count for about 25% of the total. Thus one can see the importance of these two elements for the overall consumption. The importance of micro-electronics can be realised this way. With advances in technology the price per chip is coming down. Just to quote an example a microprocessor used to cost $ 200 while its present price is between $ 10-25. This gives an impression that the equipment/systems will become cheaper. However, it is not so because a microprocessor once damaged has to be replaced and development costs of new devices are high. The software package is now costing much more than the hardware.

An easy replacement is possible in the developed countries but it is not so in the developing countries thus posing a major problem for the application of micro-electronics

in various appliances. Some of the applications have been listed below:-

- Information processing and computing.
- Machine Intelligence.
- Automation in industrial and domestic fields.
- Language translation.
- Digital tele-communications and switching.
- Electronic recording of books and publications.
- Medical electronics and a host of other applications.

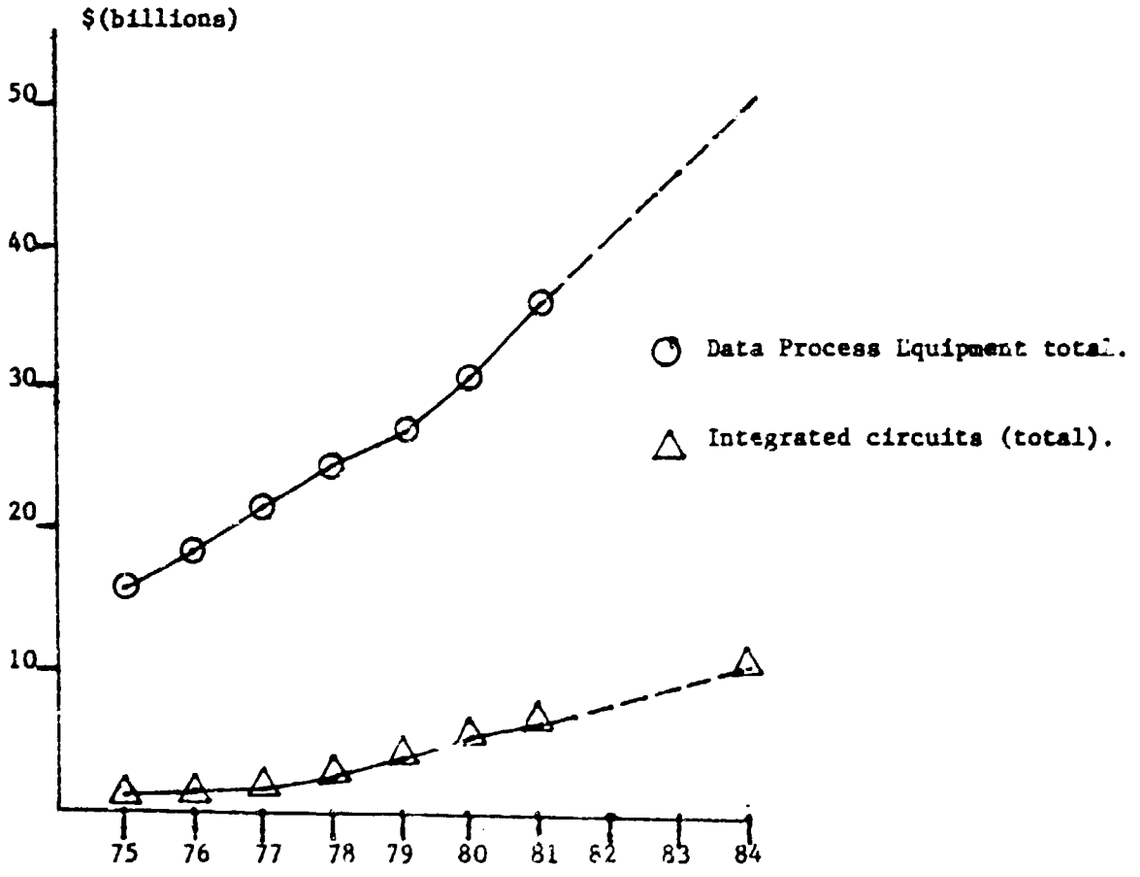


Fig. 1 Consumption of Data Process Equipment Total and Integrated Circuit-(total) in U.S. Market.

in the developing countries is manifold due to lack of:

i) advanced technology know how.

ii) trained manpower.

iii) availability of advanced components.

iv) software development, etc.

v) obsolescence of electronic products.

Before making any proposals for the application of microelectronic components in the developing countries, it will be easier to study electronics effort in a developing country such as Pakistan. The situation in other developing countries is more or less the same.

3. Case Study of Pakistan's effort in the field of Electronics.

Even amongst the developing countries, there are gradations, some are more developed than others. . —stan may be considered as approaching "more developed than others" status. In any case let us consider the status of electronics in Pakistan. The key factors which need to be considered are the requirements of electronic equipment, the status of electronics industry, manpower, acquisition of technology and other parameters such as research and development, resources and proposed investments etc.

3.1 Requirements of Electronic Equipment in Pakistan.

The total requirement of electronic equipment/component has been estimated to be $ 736 million for the 5th plan period (1978-83) this comprises of all types of electronic instrumentation required. Table-1 gives the import figure of some typical items during the preceding years.

Table-1

Imports of Electronic Equipment (Millions of $)

	1975-76	1976-77	1977-78	1978-79	1979-80	1980-81
1. Scientific, medical optical measuring and controlling inst. & apparatus.	14.39	17.24	17.94	21.398		
2. Telecommunication Equipment.	11.985	22.655	15.647	19.553	6.875	5.536
3. Electro-medical Equipment.	1.924	2.617	1.934	2.557	5.730	1.967
4. Transistors, values etc.	0.975	0.985	1.032	1.804	2.510	1.890
5. Electrical measuring & control Equipment	3.676	4.263	3.112	3.974	7.656	5.545
6. Telecom. Apparatus T.V. receivers parts.	21.207	34.045	25.222	26.683	12.449	10.102
7. Sound recorders Changers Tap recorders etc.	2.055	2.798	3.027	4.083	2.419	2.251

Since the import figures contained in Table 1 do not cover the entire range of electronic equipment therefore the imports seems to be less than anticipated targets. Another factor which is influencing the import figure could be the lack of cash resources. It may further be added that figures under barter trade with different countries have not been taken into account. Therefore estimate for the entire plan period are anticipated to be about $ 740 million are reasonable.

3.2 Electronic Industry.

The electronic industry is both in public and private sector and brief description is as under:-

3.2.1 Public Sector.

There are four industries in the public sector namely; Carrier Telephone Industry, National Radio and telecommunication Corporation, Telephone Industry of Pakistan and Equipment Production Unit of Pakistan Broadcasting Corporation. The range of product is telephone instruments, exchange equipment, teleprinters typewriters, HF & VHF receivers, power supplies, long distance carrier telephony, telegraphy as well as HF/VHF Radio Transmitters, discrete active components, passive components and printed circuit boards. The total financial outlay is approximately $ 10.3 million while annual turn-over is about $ 20.5 million. Most of the equipment is produced for local use. Since the production is unable to cope with the demand of the local market therefore export is not planned. However, there is spare production capacity available which can be harnessed, if material and man-power resources permit.

3.2.2 Private Sector.

There are 12 radio and T.V. and consumer electronics manufacturer with a capital outlay of $ 5.05 million and annual turn-over of $ 42.8 million. There is sufficient assembly capacity available for radio and T.V. in the country. Apart from that there are a number of cottage industries which are producing mechanical parts for both these items and radio kits. The production capacity has been summarised in Table 2.

Table 2

ELECTRONIC INDUSTRY - PRIVATE SECTOR

Name of Industry	Installed Capacity				Actual Production 1978-79				Total Man-power
	Radio	T.V. BW	T.V. Colour	Tape & Misc.	Radio	T.V. BW	T.V. Colour	Misc.	
1.M/s Radio & General Appliances,Lahore.	300,000	40,000	18000	2000	5300	5300	1500	150	404
2.Pak Audio-Tech.Ltd. Lahore.	-	10,000	1500	-	-	10000	1500	-	32
3. Associated Electronics Lahore	20,000	26,000	5000	10000	-	3045	-	-	83
4.R.B.Industries, Karachi.	125,000	30,000	10000	-	1916	6919	500	-	96
5.Philips Karachi	125,000	30,000	10000	10000	39726	17014	3304	2860	277
6.Electronic Industries Ltd. Karachi.	100,000	20,000	-	-	1043	7644	-	-	63
7.Pacific Traders Pak. Ltd. Karachi.	-	18,000	500	-	-	17378	-	-	60
8.S.N.H.Industries Ltd. Karachi.	90,000	36,000	-	-	-	31125	-	-	178
9.MECO Ltd.Karachi	-	24,000	-	-	-	9800	-	1224	168
10.Hyderabad Electronic Industries Ltd.Hyderabad	60,000	36,000	1200	40000	-	-	-	-	50
11.Micro-electronics Inc. Lahore.	Trial production of IC's started. Established in 1980.								
12.Micro-electronics Inc,Karachi.	Trial production of Colour TV1 tape recorders etc. started. Established in 1980-81.								
Total:	820,000	280,000	53200	62000	47985	108,825	6804	3010	1411
		3,33200				1,5636			

3.2.3 Public-cum-private sector.

A company by the name of Micro-electronics incorporated, Lahore was established in 1980 for production of custom built integrated circuits. The trial production has already started and the products are mostly meant for export. In the initial stage the processing of chips will be done by the foreign collaborators while packaging etc will be done locally. However, it is expected that by 1983 the processing of the chips will also be done in Pakistan. The said firm intends to start production of Micro-processor (8 bit, 16 bit) in 1982. The technical know how as well as part-funding has been done by the foreign collaborators.

3.3 Man-power.

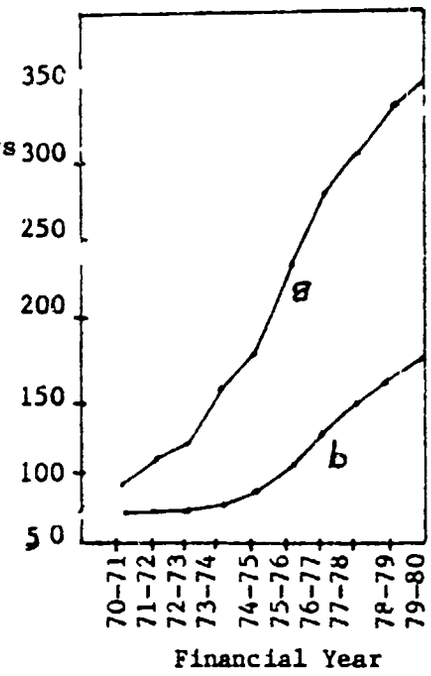
The Industries mentioned above employe approximately 220 qualified engineers and 5000 Technicians, skilled workers etc. Apart from that an estimated technical man-power of approximately 300 engineers/scientists and about 1000 technicians in the field of electronics are available in different R&D establishments of Government departments, Universities etc.

The number of persons graduating from University have been shown in Fig. 2.

The Graduate of Polytechnics which are classified as technician have not been shown in Fig. 2 because/lack of availability of yearly data, however, it has been estimated that about 300 Technicians are being produced annually from all the polytechnic Institute. These technicians have undergone 3/2 years course in radio and T.V. Technology. Thus reasonable amount of manpower is

available. However, this manpower has to be groomed for accepting challenge of advances in electronics technology through training programmes (academic and on the job)and refresher courses.

Fig. 2:
Output from universities
(a) B.Sc electronic engineers
(b) M.Sc (Physics) with special paper in electronics.



3.4 Research and Development.

The research and development efforts in electronic was scattered as different Government departments have employed R&D workers for design and development pertaining to their own needs. However, realizing the scattered R&D activity was not being very productive so the Government of Pakistan decided to establish a National Institute of Electronca which will comprise of the following Divisions:-

i) System and Circuits Division.

ii) Component Division.

iii) Microwave Division.

The implementation of the project effectively started from the end of 1980. Some research products have already been initiated for design and development and maximum local integration. The aims of the Institute are primarily to develop a production proto-type with all its documentation and then pass it on to public or private sector industries for production for local consumption or export.

The functions of the National Institute of Electronics are as under:-

a) carry out design and development work in vital areas in electronics not with the resources of the existing development centres;

b) design and develop items of common utility for the various user organizations and production units and assist in augmenting the local content in production;

c) develop know-how in advanced electronic techniques of value and exchange specialised know-how with other research centres in the country;

d) participate with other development centres in research and development projects of national importance and coordinate the work of various research centres in the country;

e) assist in advanced training in electronics;

f) design, develop and guide fabrication of electronic components, particularly integrated circuits, keeping abreast of the latest technologies;

g) design, develop and guide production of electronic measuring instruments, industrial control equipment, computing devices, medical electronic equipment and opto-electronic devices;

h) design, develop and guide production of radio and television sets, including colour television and other consumer electronic devices;

i) develop expertise in digital electronic techniques to enable its application to control systems, data processing and data transmission equipment of the future;

j) establish and maintain close liaison with other development centres. Universities, user organizations and production units for the promotion of electronic research and development activities:

k) undertake design and development projects on contract with user organizations and coordinate the work in the various development centres in case of composite projects.

l) conduct seminars on electronic topics of national interest and exchange specialised know-how with other research organizations, universities and centres of competence;

m) publish an electronics journal with the objects of disseminating knowledge and expertise and the progress of research and development work;

n) undertake small quantity production of specialised components, integrated circuits and equipment;

o) assist industry to enable increased use of local components circuits and design; and

p) assist in standardisation of components, equipment and techniques on the national level.

4. Application of Micro-electronics.

There are innumerable applications of micro-electronics in all technological fields and these are quite evident from the discussion in section-2 above. However, to name a few particular area of interest to Pakistan and other developing countries are as under:-

4.1 Data System and Computors.

There are about 40 main frames computer in use in Pakistan and innumerable number of calculators, for example, in the financial year of 1978-79 only calculators amounted to $ 1.2 million. With the use of Micro-processor and microprocessor arrays it is possible to make small computers which are likely to replace the main frame computers of

medium size. This is a very vital area because most of the work is going to computers now.

4.2 Tele-communication Equipment.

The changing over from Electro-Mechanical switching of telephone to Electronic switching has made its impact. In the financial year of 1978-79 about $ 40 million equipment was imported by Pakistan. I am sure other developing countries are also in a similar position. The use of micro-electronic in the telephone system can be small micro-processor controlled electronics exchanges and by devising a suitable software the system can be extended. Commercially such system are available upto 50000 lines which means that even a single system is good enough for medium size cities of the developing countries. This project is not difficult and can be easily taken up to replace the present electro-mechanical equipment.

4.3 Consumer Electronics.

Although Pakistan is making radio, Black & White T.V., Coloured T.V. Public address system for its own use still in 1978-79 alone the import of consumer electronics equipment was of the order of $ 10.15 million. As modern consumer electronic e uses a lot of micro-electronic products, therefore, effort has to go into Designing and Development of indigenous system in this field thus saving quite a lot of money in developing countries.

4.4 Application in Industries.

There are many uses of micro-electronic equipment in Industries and some of them have been named as under:

i) Electronically control, Machine Tool and other Industrial Plant.

ii) Automation etc.

It is well-known that with the use of micro-electronic component, the quality assurance and reliability of the developed instruments/systems improves. The electrical power requirements of such systems are very small as compared to earlier equipment. It occupies less space and the most coveted advantages is the development of a capability in the field of micro-electronics and transfer of technology in this way. In this age of electronic it is imperative that developing countries should develop a capability of using and if the requirement permit produce micro-electronic products. Generally requirement of a single country cannot justify the production facilities. However, if some developing countries can enter into bilateral/multi-lateral agreements then this industry becomes viable in various regions of the developing world.

5. Action at the National Level.

As already mentioned in Section-3 Pakistan after realizing the importance of the micro-electronics for applications in different areas has established a Micro-electronic component industry primarily for export in collaboration with a foreign firm. This will help in transfer of technology and will enhance the use of components developed by this industry for local design and develop effort of instruments and systems. At the moment this industry is doing electronic packaging but later on it will process the chips and with time it will become self-reliant for custom built integrated circuits.

There has to be a back-up for such an industry in the country. Realizing this National Institute of Electronics has prepared plans to develop integrated circuits, transducer etc. upto production

prototype stage. Thus a complimentary efforts has already been started in this regard. Attaining this technological capability is necessary both from the aspect of knowledge and skill development as well as national needs.

Since this is relatively new field, therefore, most of the circuit designers have to be re-trained in this area, therefore, National Institute of Electronics has been assigned the task of refresher courses for engineers and scientists working in the field of electronics. Since dissemination of information on current technology is necessary for development of a sizeable effort in this field so the National Institute of Electronics is going to publish an electronic journal and also going to organize national/ international conferences every year. The next conference is expected to be organized in March, 1982. For the promotion of electronics in the country research and development contracts are going to be awarded from this Institute to various scientific establishments in the country.

6. Proposal for International Collaboration.

Since any development in any area requires human and material resources, therefore, it would be necessary to consider these aspects.

6.1 Man-power.

Most of the developing countries need training facilities for modernizing the knowledge of existing engineers in the field of micro-electronics and fresh ones to be trained in the field of micro-electronic technology and application. Possibly UNDP may