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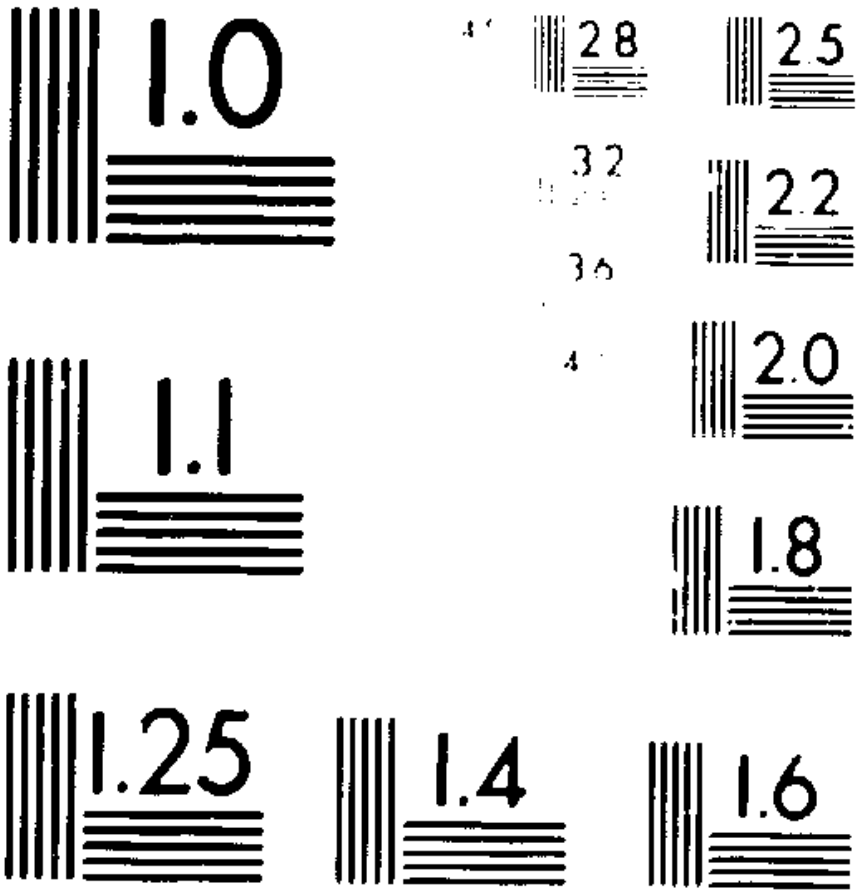

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STATE-OF-THE-ART SERIES ON MICROELECTRONICS

No. 4: PAKISTAN *

Prepared for the Technology Programme

by

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UNIDO Consultant

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EXPLANATORY NOTES

CAD	Computer Aided Design
CAE	Computer Aided Engineering
CAM	Computer Aided Manufacturing
CMOS	Complementary Metal-Oxide Semiconductor
CRT	Cathode Ray Tube
GaAs	Gallium Arsenide
ICs	Integrated Circuits
LSI	Large Scale Integrated Circuits
MOS	Metal-Oxide Semiconductor
MSI	Medium Scale Integrated Circuits
NMOS	N-Channel Metal-Oxide Semiconductor
SSI	Small Scale Integrated Circuits
VF	Vacuum Fluorescent
VLSI	Very Large Scale Integrated Circuits

C O N T E N T S

S U M M A R Y

The study reviews the state of the art and anticipated future developments of the microelectronics industry in Pakistan as well as research undertaken; current applications of microelectronics products and scope for co-operation at regional and international levels.

There are three industries in the public sector in Pakistan assembling telecommunication equipment. Their annual production capacity is 130 million US dollars. Ten industrial units exist in the private organized sector for TV and radio/cassette recorders with an installed capacity sufficient for home market and some exports. Expected additional investment up to 1988 for microelectronic products is US dollars 75 million.

Pakistan's strategy is the transfer of technology in the field of microelectronics appropriate to establish indigenous capabilities. Recently an International Centre for Science and Technology was set up in Karachi. It is expected to undertake R and D work in microelectronics technology.

There are six R and D organizations specifically working in the field of electronic products. The universities and other Government Agencies are also conducting R and D in microelectronic applications.

Manpower in electronics has an annual production rate of 1,000 professionals and technicians. The Pakistani professionals and subprofessionals working overseas are 3,000. About ten organizations impart training in the field of computer technology.

Regional/international co-operation is most welcome in the field of microelectronics technology. Pakistan can offer Degree Level, Master Level, Diploma, Certificate Courses in electronics and computer technology. On the other hand, Pakistan would like to benefit from international co-operation in the field of application software, higher education, design and fabrication of integrated circuits, CAD/CAM, robotics, etc.

1. MICROELECTRONICS-STATE OF ART-TECHNOLOGY TRENDS

1.1. STATE OF THE ART

Electronics technology is going through a revolutionary phase. Major developments in the refinement of the technology are taking place so rapidly that this technology has become the fastest expanding technology of the modern times. The main inputs to this expansion have come out of microelectronics. The micro-miniaturisation is to implant complete electronic circuits involving thousands of active electronic components on a substrate of a semiconductor. The density of micro-circuits, most commonly called integrated circuits is increasing very fast through reduction in the feature sizes which have already reached the value as small as one micron with spacing between features of the order of two microns. With such refinements about 660,000 active electronic components on a single $\frac{1}{4}$"x$\frac{1}{4}$" chip have been made - in fact a complete 32 bit micro-computer. Manufacturers are actively striving to develop newer technologies which would enable further reduction in the feature size-perhaps to as low as 0.1 micron. The components on a given chip would thus increase in number and according to a forecast some three million of these may be accommodated

on signle chip by 1990, or perhaps earlier. In order to increase the operating speed of these complex circuits newer technologies like silicon on insulator (SOI) and silicon on sapphire(SOS) have been examined. During the experimental phase SOI chips were found to be 3-10 times faster than the conventional silicon circuits.

An altogether different approach has been tried when silicon semiconductor was replaced with another semiconductor called gallium arsenide(GaAs). The characteristic of this semiconductor is that it has a speed improvement over the silicon circuit by as much as 6-10 time. The other advantages are less power consumption and better radiation resistance. The gallium arsenide technology is under development and in some cases it is successful for production runs. It is estimated that by 1990 most of the defence equipment will employ gallium arsenide as a substrate for microcircuits. Naturally it will have spin-offs in commercial fields. Other bi-metallic & semiconductors are also promising but the technology is yet to be proven.

The Josephson Junction devices are 20 to 50 times faster and consume 0.001 per cent or less power than the silicon integrated circuit but then it operates at temperatures of liquid helium. The requirement of main-

taining the Josephson Junction at such extremely low temperatures, however, has not proved as a real impediment and some companies have already put this in practical devices. A binary counter which can operate at 100 GHz has been produced. It is known to be the fastest counter and perhaps the fastest digital circuit of any kind ever demonstrated. In addition to being able to work as event counter the device can be used for development of analog-to-digital converters which are very fast and very accurate.

To succeed in reducing the feature size to such low values as micron or submicron size, it was necessary to perfect altogether new technologies which call for an extremely fine precision and highly controlled environment in the work areas. It is quite obvious that ordinary light could not have been used for transferring of circuits through the masks on the semiconductor chips because of the diffraction problems. Even deep ultraviolet light would suffer from handicaps. The current techniques have focused on using X-rays and even electron beams technique for submicron feature sizes. Another technique for fine feature sizes which has been successfully tried is called ion implanatation.

With such high density circuits, although the ability of the microelectronic circuits to perform operations may go exceptionally high but technology-wise there are several other problems which are quite challenging. For example the requirement that the chip holding this complete circuit should be free from any impurity or imperfections becomes even more stringent. Even few atoms of radio active impurity resulting in emission of radiation at random have been traced as the cause of serious problems in the performance of these circuits.

Another area where concentration is necessary is the need to ensure power dissipation from these high density integrated circuits. The systems like computer which employ these high density circuits may be dissipating heat load with individual micro-circuits contributing as much as 5 watts. In the latest devices simple air cooling has proven to be inadequate and so may be the large fin area conductive cum radiative transfer. Systems have been devised which employ water or Freon gas cooling to dissipate such heavy heat loads. The performance of the integrated circuit as well as its lifetime may be affected by the ambient temperature at which it is operating. Most

reliability experts agree that each $10^{o}C$ rise in junction temperature reduces the lifetime of the integrated circuit by half.

When the integrated circuits are to be used in space applications where the background radiation level may be very high, it is important to ensure that these would operate in high radiation conditions. The so called radiation hardened integrated circuits and other electronic components for such specialized applications are now in the process of production. For these integrated circuits, the condition is that these should be able to operate satisfactorily in a radiation environment of at least 10^{4} rads without suffering from radiation induced failure. Gallium arsenide circuits by the very nature of semiconductor material have proved to be much radiation hardened as compared with silicon integraded circuits.

The high density integrated circuits with increasing speeds, compact in size and reduced power consumption have proved a real boon and driving force for the computer industry. The microprocessor and microcomputer

industry which was born only 10 years ago had crossed the one billion dollar sales barrier in 1980 and is projected to grow to about five billion dollars by 1985 which shows an unbelievable increase of 32 per cent a year. There are already some 1,000 manufacturers of computers of all sorts in the world market. The most pervasive of all the computers is the microcomputers which is also now being called the desk top computer or the personal computer. According to another forecast more than 12 million units of microcomputers will be marketed world-wide over the next five years, reflecting a combined annual growth rate of 59 per cent. In terms of money it would exceed 11 billion dollars by 1986. The US market potential is currently in excess of 25 million units and has not been substantially penetrated. These personal computers though small in size and easy on the pocket (about 1,500 dollars or so), have surprassed the capability of their very large size ancestors.

The computers have established firmly in the industry, research and development laboratories, offices, schools and households. The microcomputers are bringing about energy conservation. The microcomputers have given rise to an industrial revolution and new economic order. These have brought about high rates of production, stringent quality control standards and automation.

Computers have improved efficiency of human beings to a very large degree leaving them free for really creative pursuits. New experiments are being conducted whereby they will translate the written and spoken text and translate it into different languages and even transform typed material into synthetic speech. Computers, space technology and communication engineering will enable holding of teleconferences involving people based thousands of miles apart. Microcomputers will become powerful tools as teaching aids in schools, colleges and universities. The most revolutionery part of the whole deal is that computers will help design and run most complex species of equipment and systems. The computer aided design(CAD), computer aided engineering (CAE) and computer aided manufacturing(CAM)have revolutionised design and production techniques. The fact is that the computer is really allowing the engineers to design the computers of tomorrow having higher and higher levels of complexities and capabilities, for example, robots. They are performing hazardous jobs and now even mundane jobs. This is a brand new field and microcircuits have given rise to it. Work is already going on the development of fifth generation computers which will have intelligence and also ability to learn from their experiences and take

decisions autonomously. This will be done through super large scale integrated circuits, perhaps based on 0.1 micron feature size using materials such as Indium Arsenide or Gallium Antimonide which are potentially 20 times faster in operation than silicon.

Computers by themselves cannot be of any use unless they are programmed to operate according to present instructions. The United States has a clear lead in software over any other country including Japan. However, Japan is making strides in this field. With microcomputers, the ratio of hardware cost to the software cost is going in favour of software. Software development, therefore, can be a lucrative and promising pursuit especially for the developing countries, for this does not require large outlay of capital investment. The software so developed can be easily exported to the developed countries who would be the primary users of computer hardware in the years ahead.

Rapid research and development has been made in millimetre wavelength technology i.e. extremely high frequency signals covering frequency range from some 40GHz to 140GHz. At such frequencies the sizes of the components can be very small including the size

of the antenna say for the purpose of a radar. With rapid advances in brand new fields of electronics such as millimetric wavelength technology, lasers and fibre optics, microelectronic technology is regarded by the developed countries as one of their highest priority and key areas for further research and development. The secrets of technology are jealously guarded so that they do not leak out. It is quite clear that microelectronics has come to stay and to play a vital role in the industrialization of nations to contribute mainly towards the socio-economic well-being of people. The challenge is to be faced squarely by all countries in the world.

All the new equipment which is being manufactured in the world is employing microcircuits. The analogue

techniques have been shoved to the background. Now is the time of the digital electronics. The techniques to operate and maintain the analogue equipment and digital equipment are quite different. New equipment needs more looking after, higher level of skills among technicians who have to maintain this equipment and better temperature and environmental controls. The developing countries have imported and will continue to import billions of dollars worth of equipment which would be based totally on microcircuits. It confronts them with the dilemma as to who will maintain it. One microcircuit having hundreds of thousands of active components going out of action will render the entire equipment inoperative. So the need of the developing countries, is that they must go all out for training in large numbers manpower in maintenance of equipment and systems based on micro-circuits. They need to develop teams of skilled manpower specialising in computers; their operation and maintenance. There is also a need to train a large number of Scientists and Engineers and others who could perform the jobs of system analysts, software adaptation and software development. All these are brand new areas of specisation. The developing countries lagged behind in realising the need for training teams of experts in these areas to be available in their own countries.

These teams backed up by adequate number of testing, checkout equipment(most of it computer automated systems) and repair services are essential to keep the sophisticated equipment going and the to prevent the disaster which otherwise would strike almost immediately after this equipment has been put to use.

Then there is priority for establishment of industries which lead these countries into development of the technology of microcircuits. How to go about it? Set up industry for production of high grade semiconductor materials suitable for microelectronics and photovoltaic cells. To start with silicon may be chosen. Then there is need to go into the technology of integrated circuits fabrication. If it is not feasible, assembly may suffice in the beginning to train manpower. The usual excuse that there is not enough demand for these microcircuits or the photovoltaic cells in the country to warrant establishment of industry within developing countries is untenable and leads these countries into a vicious circle of no progress and stalemate. Why can not the expertise be developed and environments conducive to foreign capital created to attract transnational companies to set up these high technology industries in the developing countries which would bring about technology transfer on the one hand, and take care of the

marketing problems on the other hand since transnationals will take out the produce for selling in their own established markets. Even otherwise industries in microcircuits technology established by local enterpreneurs with technical know-how from foreign manufacturers of repute can be a viable economic proposition. The foreign collaborator would be pleased to buy back the produce provided he is assured of consistently high quality of the products.

1.2. TECHNOLOGY TRENDS

The revolutionary changes which are likely to usher in the near future have been summarized areawise:

1.2.1. ENGINEERING SOFTWARE

The software industry is exploding, and the search is on for ways to improve the writing of new programmes. Among the tremendous developments are: a vertiable explosion in CAE systems that will continue to broaden and logic designers tool kit; the migration of design and test functions towards microcomputers, in both the digital and the analog field; a concentration of fewer operating systems, with an emphasis on such interface enhancements as windows.

A slow but steady evolution of expert systems, which will eventually relieve software and hardware designers of routine chores. In addition, productivity improvements are possible, even today - not just with automation, but simply with better planning and control.

The actual trends present mixed signals. On the plus side, the move towards standard operating systems is gaining momentum, and hardware is emerging that can accommodate several operating systems simultaneously, reducing the need to customize existing application packages. Furthermore, the rising popularity of Unix is widening the distribution of its software tools, while new tools are finding acceptance both inside and outside the Unix Community.

1.2.2. PERSONAL COMPUTERS

The personal computer, the self-contained desktop microcomputer intended for one user, is just now approaching the peak of its technological development. The trend (so typical of the electronics industry in general) has been to put more intelligence and memory in smaller packages at lower cost. But this machine, at least in its present form, may have reached a watershed.

In fact, the drive to maximize its computing power has sown the seeds for new category - supermicrocomputers that will be shared by multiple users.

The first supermicrocomputers are here, and more will come. True to form, successive machines will bring ever greater computing power, larger memories, and higher speeds. These machines will employ 16 to 32 bit microprocessors with standardized high performance structures such as the VMEbus and Multibus II. As for software, Unix and Unix-like operating systems will dominate the field.

Over the short term, there will be some interest in integrating existing personal computers(such as the IBM PC or Apple II) into an office, factory, or engineering environment using networks, intelligent file servers, PBX switchers and other cluster controllers, and a variety of software packages. The practical problems of operating a variety of computers through a common interface and shared file structure will ultimately encourage the use of supermicrocomputers.

1.2.3. SEMICUSTOM ICs

By the end of the decade, the advances being made in semicustom IC technology and its wide range of

necessary support tools will permit more than 50% of all VLSI Circuits designed to be assembled from building blocks pulled from computer libraries. Even now, the designer has a variety of choices: prediffused arrays in bipolar, CMOS, or NMOS technologies: standard cells in bipolar and CMOS: and fuse programmable logic arrays of many kinds - thus furnishing a wide performance range to suit many different systems.

In addition, combinations of technolcgies are continually being added to the list, mixed analog and digital functions have been available for some time in bipolar arrays, and their CMOS counterparts have just recently come on the scene with high-performance analog functions, and even more recently with the ability to handle very high voltages.

Already, CMOS technology has taken a dominanat position for new chip designs because of its lower power consumption. This ascendancy will become even more pronounced over the next few years as CMOS speeds up to the point where it computes head on with all but the fastest bipolar or gallium arsenide arrays. Additionally, CMOS is mixing on chip with bipolar technologies to aid designers who need high current sinking or sourcing.

As more the silicon implementation is handled by software, the design approaches in both the analog and digital areas are starting to merge. In fact, now in the early stages of development are two more approaches; the structured design and the silicon compiler which rely heavily on the ability of software to synthesize circuits from logic descriptions.

1.2.4 POWER CONTROL

Driven, finally, by the realization that interfacing with the real world requires not only the acquisition of information from transducers but also the precise control of power from a few watts to hundreds of megawatts the designers of digital systems are turning to semiconductors for easy system type solutions to this new problem as well. Power control semiconductors for a long time the ugly duckling of LSI, have not been found wanting. In fact, by taking advantage of the innovations in circuit design, processing, and assembly of the past decade, the power field should lead the semiconductor industry in exciting developments in the next stage.

The primary spur is advances in power MOS technology, which are occurring so fast that they are hard to keep up with. The second made possible by the

first is the merger of MOS and bipolar power technologies.

Together, these two are creating the power control IC, not about where the IC op amp was five years ago but with a potential the op amp never dreamed of. Meanwhile, developments in hybrid power circuits made up on only a few chips will ensure a steady gain in isolation voltage ratings, current handling capability and circuit complexity.

One of the highlights will be the inroads made by a new type of power semiconductor, the conductivity modulated device, which combines bipolar and MOS structures, however, power MOS transistors will reach new heights in voltage ratings, speed, and current handling capability. Moreover, power MOS devices will appear that can directly interface with 5-V logic, and others will show up in dielectrically isolated tubs on monolithic ICs. A broad family of existing bipolar power transistors will switch over to power MOS processing.

1.2.5. FACTORY AUTOMATION

The watchword for the push toward factory automation is networking. However, the task is complicated by the extremely broad variety of machines, components and

processes that must be linked.

Work stations for computer aided design and manufacturing will be only part of the picture. Robots will increasinly appear, supporting greater intelligence, more dexterity, and a host of technical and vision sensing capabilities. Furthermore, a great deal of power can be expected from 32 bit computers, which will begin controlling sophisticated graphics terminals, while low end microcomputer boards assume local controltasks on the assembly line. The attempt tc tie these diverse machines and their support components into a cohesive network software but also on universality, a concept that will bring a degree of harmony to these vastly assorted factory elements. Perhaps the most long-awaited factory instaliation will be expert systems, still a novelty in many fields. These artifical intelligence setups promise to improve management and scheduling and may eventually enable robots to make intuitive decisions.

Despite the vigorous and enthusiastic efforts of the electronics industry, the fully automated factory is still a long way from complete. Some critical stumbling blocks must be surmounted. For instance, many systems that claim to be suited to both CAD and CAM

actually handle more design than manufacturing functions. Although they can graphically generate tool path programmes to drive numerical controllers and other machine tools, their capabilities at the manufacturing end fall short. They cannot control dimensional accuracy to the sixth or eight decimal place, a level of precision essential to manufacturing parts with complicated shapes and counters.

1.2.6. DISPLAY TECHNOLOGY

In the realm of high resolution the cathode Ray Tube (CRT) still reigns supreme, and it will keep its crown at least until the decade is out. Flat panels which will one day share the throne, continue to improve in terms of speed and colour response and to reach for greater clarity. Unlike previous years, however, the kind of progress made in flat panels in near future will be a function of the manufacturer's location.

The last few years, for example, have seen considerable advances in the U.S. and in Europe toward larger, higher resolution full color flat panels.Now the work will centre on refining that technology. Fueled by the growing demand for practical cost effective displays, competition from Japanese R&D, and an improving economy, efforts will concentrate on improving the "Blue Chip"

technologies like liquid crystal and vacuum flourescent. At the same time, involvement in areas that no longer show much promise, such as electrochronics and electrophoretics will be minimized. In Japan, on the other hand, the emphasis will be as much on pure research and long term returns as on sales.

Vacuum fluorescent(VF) units, generally regarded as the most mature of the current active element technologies, will continue to proliferate in the automotive field despite the challenges mounted by liquid crystal displays. It is also likely that the VF will be closely scrutinized by the Japanese, who hope to bring it to full colour TV. Electroluminescent displays are also to get a tremendous boost with NEC's effort in Japan.

2. MAIN FIELDS OF APPLICATION OF MICROELECTRONIC EQUIPMENT PURCHASED LOCALLY AND BROUGHT FROM WITHIN AS WELL AS OUTSIDE THE REGION.

There are over 100 subdisciplines of electronics. Due to miniaturisation, reliability assurance, quality control and special applications in space and military weapons the micro-electronic products have penetrated in all types of electronic equipment and systems. In addition to that the new type of devices such as radiation hardened integrated circuits, high speed LSIs, Josephson effect devices, charge coupled devices and other super conductors have added a new dimension in the development of electronic technology. In the year to come the application of all these new devices will bring more advanced and sophisticated electronic instruments and circuits for various applications.

Before any country can enter the field of micro-electronic technology it is necessary to assess the annual requirements of the electronic equipment and systems for its own needs as well as for export. As far as Pakistan is concerned various surveys have been conducted to assess the requirements of electronic equipment and systems in 1974, 1977, 1978, 1980, 1982 and 1983. Since the data has been regularly updated, therefore, the requirements are based on the 1983 survey. The annual requirements of all electronic equipment and systems required in Pakistan amounts to $ 300 Millions. The details of various sub-sectors are in Table 1.

TABLE 1

ANNUAL REQUIREMENTS OF ELECTRONIC COMMUNICATION EQUIPMENT

S.NO.	USER/FIELD & RANGE OF PRODUCTS	MILLION $
1.	Telephone and Telegraph Department	
	- Electronic Public Exchange Lines - Multiplex equipment - Electronic Teleprinter - Push button dial Telephone - VHF Systems(single channel during the period) - VHF (Multi Channel) - PCM equipment(channel) - UHF (multi channel)Trmls. - M.W. (7GHZ) Trmls - N.W.D.Equipment(channels)	85.00

2. Telecommunication Equipments for various Users.

- Radio Sets - Walki-Talkie - SSB Transmitter - SSB Receiver
- Receivers of various types - Field Exchange (Line) - Electronic Telephones. 22.5

3. Railway/Wapda etc.

- SSB Fixed Frequence Coms. set - SSB Waves changeover coms. set
- Waves traps(various ampearage) - Coupling capacitor(various voltage) 66KV-500KV. - Protection devices - Electronic Private Branch - M.W.(7GHZ) Trmls. - Multiplex equipment for 7GHZ for 60 Channel N.W.System(channel) - Multiplex equipment for 1.5 GHZ(36 channel) system - VHF single channel sets - Signal contorl system(Wheel Sensor, Micro Processor) 7.5

4. Entertainment equipment

- Black/White TV - Colour TV - Radio/Radio Cassette. 113.00

5. Computers and Computing devices.

- Main Frame Computers - Mini Computers - Micro Computer
  i) 8 bit ii) 16 bit iii) 32 bit - Display devices 7.5
- Input/output devices - Remaining peripheral equipment
- Storage devices-Memories.

6. Electronic Components and accessories.

- Passive Components - Active Components - Diodes of various types - Transistors of various types - Integrated Circuits 15.0
- Large scale integrated circuits - Very large scale integrated circuits - High speed very large scale integrated circuits
- Custom built integrated - Micro Processor - Opto electronic devices - Advanced electronic devices.

7. Raw Materials for electronic Components and Hardware.

- Ceramic Parts - Glass - Ferrites - Fibre Glass - Silicones
- Resistors - Capacitors - Semi Conductors - All fine mechanic parts including tools needed for housing & mounting of Electronic Circuits. 15.0

8. Miscellaneous Electronic Equipment.

- Electro Medical Equipment - Microwave Equipment - Industrial Controls - Electronic Office Machines - Digital Communication Equipment - Opto Electronic Equipment - Others 34.5

Thus the annual requirements of electronic equipments and systems for Pakistan alone is $ 300 million. Keeping export market in view initially 20% which is likely to increase later on to 50%, the total estimated requirements for the Sixth Plan Period will be approximately $ 2.0 billions.

3. MAIN SUBSECTORS OF MICROELECTRONICS INDUSTRY DEVELOPED WITHIN THE COUNTRY

Before embarking onto the Microelectronic Industry it is necessary to define the industrial infrastructure in electronics in the country. As such the existing electronics industry is being reviewed and it may also be noted that microelectronic products are finding their way in the industries mentioned hereunder thus with the introduction of the use of integrated circuit,VLSIs etc. the existing industry will have to be modernized.

3.1. EXISTING ELECTRONIC INDUSTRIES

The electronic industry in Pakistan is both in public sector as well as in private sector.The radio,TV and entertainment equipment are in the private sector. According to the 1982 assessment the annual production of TV and Radio is as under:

1. TV Black and White = 120000
2. TV Colour = 30000
3. Radio/Radio Casette Player = 1000000

As far as assembly of radios is concerned about 60% of the annual production is being manufactured by cottage industry while the remaining production is in the organised private sector. The production of TV is totally in the organized sector. The installed capacity for 10 industries for the production of TV, etc. is given in Table 2.

TABLE 2

ASSEMBLY WITH CAPACITIES AS PER REPORT JUNE 1980

INSTALLED CAPACITY

S.NO.	NAME OF INDUSTRY	Radio	T.V.	Colour	Tape & Miac.
1.	M/s Radio & General Appliance Lahore.	300,000	40,000	18,000	2,000
2.	M/s Pak Audio-Tech.Limited Lahore	-	10,000	1,500	-
3.	M/s Associated Electronics,Lahore.				
4.	M/s R.B.Industries Karachi	125,000	30,000	10,000	-
5.	M/s Philips Karachi.	125,000	30,000	10,000	10,000
6.	M/s Electronic Industries Ltd. Karachi	100,000	20,000	-	-
7.	M/s Pacific Traders Pak.Limited Karachi	-	18,000	350	-
8.	M/s S.N.H.Industries Limited Karachi.	90,000	-	-	-
9.	M/s MECO Limited, Karachi	-	2,400	-	-

10.	M/s Hyderabad Electronic Industries Ltd.Hyderabad	60,000	36,000	1,200	4,000
		820,000	230,000	53,000	62000
			3,33200		

As far as the industries in the public sector are concerned these are mainly for tele-communication equipment. The annual proposed production during the Sixth Plan period is given in Table 3 alongwith monitoring equipments.

TABLE 3

ANNUAL PROPOSED PRODUCTION THE SIXTH PLAN PERIOD

S.NO.	MANUFACTURING INDUSTRY AND PRODUCTS	VALUE $ MILLION
1.	TELEPHONE INDUSTRIES HARIPUR	
	- Electronic Public Exchange(lines)(including private branch exchanges) - Electronic field telephone exchange(lines) - Electronic push button dial telephone - NWD equipment(channel) - Electronic Teleprinters.	68.0

2. NATIONAL RADIO TELECOMMUNICATION CENTRE, HARIPUR

- Walkie Talkie sets - Telecommunication equipment - Receivers
- VHF single channel sets 16.0

3. CARRIER TELEPHONE INDUSTRIES, ISLAMABAD

Multiplex equipment(channel) - UHF/VHF(multi channel) - P.C.M. (channel) - Portable transceiver - SSB fixed frequency carrier sets 29.0 - SSB wave changeover carrier sets - Wave Traps - Protective Electronic devices - M.W. terminals.

The bais of estimation for telecommunication requirements as well as T.V. and Radio sets is given in Table 4.

TABLE 4

BASIS OF ESTIMATION FOR TELEPHONE REQUIREMENT

S.N.	BASIS	RATIO	ESTD.NO.OF TELE-LINES.
1.	GNP (in million) for 80-81 $ 24903.8	8 Telephones per 100000$	1992304
2.	Total Urban House 3554178 28%	1 Telephone per 2 houses.	1777086
3.	Total number of TV sets 1400000	1 Telephone per TV set.	1400000
4.	Total Number of vehicles 1800000	1 Telephone per vehicle	1800000

Estimated average number of telephone lines = 1742348

The public sector industries have the following facilities and installed capacities as per Table 5.

TABLE 5

MACHINE CAPACITY ON SINGLE SHIFT BASIS FOR ONE YEAR IN TIP

NAME OF MACHINE		INSTALLED CPACITY
Truning	(a)	16,000 Hrs/Year.
	(b)	42,000 "
Threading		10,00 "
Drilling		18,000 "
Presses(6 to 10 tons)		2,00,000 "
Spot Welding		13,000 "
Arc/gas Welding		3,000 "
Shearing		5,000 "
Extrusion		1,500 "
Heavy duty press		1,000 "
ELECTROPLATING		
Copper/Nickie Plating Automatic Plant.		1,500 "
Silver/Gold Plating		1,500 "
Chrome Plating		1,500 "
Tin Plating		1,500 "
Zinc Plating		1,500 "
Painting/Varnishing		10,000 "
Releys (ris 70 r)		4,00,000 P/Year
Magnet Coils		6,50,000 "
Transformers		10,000 "

Telephone instruments	80,000	P/Year
Induction Coils	1,00,00	"
Fuse Strips(Sich 32 e)	3,000	"
Tag Blocks	20,000	"
Heat Coil	6,00,000	"
Call Meter	80,000	"
Motor Switch	40,000	"
Resisters	10,00,000	"
Condensors	3,00,000	"
Test relays(High speed relays)	40,000	"
Twin Relays	50,000	"
Receivers	1,00,000	"
Microphones Carbon	1,00,000	"
Selector Frames	2,000	"
E.M.D.	40,000	Lines
Production Hours	30,00,000	Hours.

3.2. FUTURE TRENDS

Government is encouraging to setup industries in the field of electronics. The authorisation has already been issued for the following industries:

4 Units for TV picture tube reconditioning as per following installation capacities shown in Table 6.

TABLE 6

S.N.	NAME OF APPLICANT	VALUE OF PLANT AND MACHINERY	CAPACITY PROPOSED.
1.	Mr.Anwarul Islam,UK	$ 10000.00	3600 Nos.
2.	Mr. M. Umer,London.	$ 10,000.00	3000 "
3.	Mr.Syed Reshid Ehsan, Kuwait.	$ 17,000.00	2000 "
4.	Mr.Irshad Hasan Shah, U.K.	$ 8000.00	800 "
5.	Mr.Mohammad Yunus Chaudhry,U.K.	$ 40,000.00	2000 "

TV PICTURE TUBE

It is going to be a joint venture of public and private sector. The total technological know-how will be obtained from some foreign source and indegenous TV picture tube for black/white and colour TV will be made. The factory will have a possibility to increase the annual production. The programme will be arranged in such a way that initially black/white picture tubes will be made and very few units of colour picture tubes will be produced. Later on the black/white picture tubes will be phased out and colour picture tubes will be increased by the same proportion.

The industry will also develop capabilities for making of Cathode Ray Tubes(CRT)both in black/white and

colour and also develop capabilities to go into high definition TV picture tubes. The possibility of other types of displays such as electroluminescent etc. will also be planned for future expansion.

ENERGY METER

The industry making energy meters(KWH meters) of electromechanical types is already established in the country. A new industrial unit has been sanctioned for making electronic KWH meter with an installed capacity of 600,000 units per year.

A number of industries which are likely to be sanctioned in the Sixth Plan period are as follows:

1. Resistor manufacturing 2.Printed Circuit Board.
3. Capacitor Manufacturing. 4.Public Address systems.
5. Speakers. 6.Test Instrumentation etc.

The existing and planned industries pertaining to microelectronic products are covered in a separate heading,therefore relevant data will be given in the respective chapter.

3.3. EXPECTED INVESTMENT SCHEDULE FOR THE SIXTH PLAN PERIOD (1983-88)

The emphasis on electronic industry has been raised in the sixth plan period. The expected investment is shown as in the Table 7.

TABLE 7

S.NO.	SECTOR	EXISTING CAPACITY $ MILLIONS	REQUIRED ADDITIONAL INVESTMENT $ MILLIONS
1.	Communication Equipment		
	PABX,PBX EPBX - Electronic Telephones - Radar & Microwave Equipment Transmitter - Walky-Talky - Telephone Telegraph Equipment - Word Processor.	22.5	20
2.	Office Machines		
	Electrical Typewriters - Telex Machines - Duplication Machine - Photocopying Machines - Other Office Machines Calculators - Computers	7.5	16.5
3.	Consumer Industry		
	TV sets - Radop/Tape Recorder - V.C.R.	7.1	4.6

4. Electro-Medical Equipment

Electro cardiograph - Multi-channels - Heart monitors - Coronary case units - Exercise Tolerance system - Ultra sonic tomographs - Radio Therapy equipments - Electronic Beds - 7.5

5. Electronics Components and Materails

Capacitors - Resistors - Transistors - Diodes-Potentiometers - Integrated Circuits - Tuners-Flyback Transformers - TV Picture tubes. - 22

6. Cassette Manufacturing

Audio Cassettes	2.0	4.6
Video Cassettes.		

4. GOVERNMENT TECHNOLOGY STRATEGY AND RESPECTIVE IN THE FIELD

Pakistan has a population of about 85 million and land area is about 796,100 sq.K.M. The Fifth Plan period expired in 1982-1983 and the document for the Sixth Plan period i.e.1983 to 1988 has been published. The gross financial outlay for the 6th plan period is $ 22.93 Billion. The salient features of the Sixth Plan are given hereunder.

4.1. TECHNOLOGY STRATEGY POLICY

- Encouragement of the private sector to set up industry particularly high technology industries in the current plan period. Sufficient funds have been earmarked and a number of incentives like tariff restructuring, reduced duty on capital equipment, reduction in corporate Tax five years exemption from income tax and facilities of credit from National and International monetary organizations.

- The Government has made a commitment that the industries will not be nationalized.

- Foreign investors, either on their own or in collaboration with local firms, have been given additional incentives. The invested capital and profit can be expatriated.

- The Expatriate Pakistanis are being encouraged to set up individual or joint ventures in Pakistan in the field of high technology.

- The procedures for obtaining licences and removal of cumbersome procedure, only one window operation has been set up which can give the licenses within the shortest possible time.

- De-regulation of the previous monetary and fiscal measures has provided an easy method of avoiding the various restrictions imposed for setting up of high technology industries.

- The investment in electronics has been increased from $ 3.5 million in the previous plan to $ 33.5 million in the 6th plan.

- The research and development work has been attached so much priority that the funds earmarked for science and technology in Pakistan are four times as compared to the funds available in 5th plan period.

- The industrialists are being encouraged to set up cottage type and main industries in less developed areas of Pakistan. Further incentives are provided to such parties by the Government.

- In the case of foreign investors, the public sector can be a party for a joint venture on equity basis.

- The industries in the public sector are being passed on to individual ownership except for heavy industries.

- The public sector role is promotional and major emphasis is on private investment.

- The element of mixed economy i.e. public sector and private sector will continue with a spirit of competition.

- The improvement in the quality of products and effective measures for reliability assurance for the products will be made compulsory for all industries.

4.2. EXPORT PROCESSING ZONE INDUSTRIES(EPZ)

The export processing zone industry is a special type of industry which has advantages over other industries in Pakistan. Its not possible to give the detail but brief outline of advantages can be given.

4.2.1. ELIGIBLE ENTERPRENEURS.

The following categories of persons shall be eligible to establish industrial undertaking in the Zone.

- a foreign investor with repatriable investment
- a foreign investor in collaboration with another foreign investor or a non-resident Pakistani national with non-repartriable investment, and
- a non-resident Pakistani national with non-repartriable investment.

4.2.2 MODE OF INVESTMENT

- All investments in the Zone shall be made in convertible foreign currencies

- Investors have the option to establish public or private limited companies of sole proprietorships or partnerships.

4.2.3. INCENTIVES/FACILITIES

- Exemption from Federal, Provincial and Local taxes including custom duty, sales tax, octroi charges etc.

- 5 year tax holidays on income and corporate tax

- Double taxation relief

- Investment guarantee

- Repatriation of capital and profit on foreign investment of foreigeners

- Liberal Labour Laws

- Liberal banking and insurance facilities

- Availability of trainable, skilled and low cost work force

- Telecommunication facilities including International Subscribers Dialling

- Simplified administrative procedures

- The domestic market also available subject to normal import policy.

4.2.4. PREFERRED TYPE OF INDUSTRIES

For establishment in EPZ those industries are preferred which

- offer advanced technology

- yield maximum "Domestic Value Added"

- make maximum contribution to the "Value Added" relative to the consumption of external utilities such as water and electricity

- create linkages with industries in the tariff area without competing with export-oriented industries of Pakistan.

4.2.5. INDICATIVE INDUSTRIAL SCHEDULE

- Electronic items, Audio and Video equipments, Computer Hardware & peripherals
- Measuring, regulating and control instruments
- Light and precision engineering items
- Sophisticated electrical engineering items
- Cinematographic and X-Ray Film, Video and Audio Cassettes
- Photographic, optical, electro-medical cinematography, X-Ray equipments
- Durable consumer goods, refrigerators, air-conditioners,deep freezers,vacuum clearners etc.
- Wooden and Stone Products
- Fibre glass/plastic/rubber components
- Ceramics and specialised glass products, laboratory glass

- Petrochemicals, chemicals, and pharmaceutical items

- Readymade garments and specialised textile processing plants

- Other industries allowed under Government policy.

5. NATIONAL R&D IN THE FIELD; PROSPECT OF REGIONAL COOPERATION

The research and development activity in the field of Microelectrics will be naturally either on the development of technological know-how or the use of microelectronic products(integrated circuits, LSIS, VLSIs micro-processors) for various applications. The development of software would also form a part of it. There are a number of institutions which are doing R&D work in the field. A brief outline of the activities of these institutions are as under.

5.1 NATIONAL INSTITUTE OF ELECTRONICS, ISLAMABAD

The institute was established in 1980 and by 1983 active research work started in the use of microelectronic products as well as software development. By 1984 R&D work in the field of fabrication of integrated circuits and other electronic devices will be initiated . The aims of objectives of the institute are as under

(a) carryout design and development work in vital areas in electronics not within 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 liasion 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 specialized know-how with other research organizations, universitites and centres of competence;

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

(n) undertake small quantity production of

specialised components, integrated circuits and equipments;

(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.

5.1.1. THE MAIN AREAS OF R&D ACTIVITY

(a) Test equipment

Power supplies
Digital multimeter
Frequency counter
AC Volt. Stabilizer.

(b) Computers/Micro processor application

Single Board computer 8 bit
Micro processor based PABX
Software development
Processes control application of micro processors
Single board computer kits for educational purposes.

(c) Communication

Paging system
TV remote control
Other communication projects.

(d) Control applications

Motor speed controller
Process control
Other control applications.

(e) Medical instruments

5.1.2. MANPOWER

The present manpower of the institute is 40 professionals and it is expected to increase the professional category up to 90 by the end of 1984. Apart from that there will be an equal number of sub-professional staff. The total strength will be about 250.

5.1.3. MAJOR FACILITIES:

Microprocessor development system Hp 64000, printed circuit board facility for single and double sided printed circuit boards, teaching and training facilities, workshop, component stores, PCB design facility, etc.

5.1.4. PUBLICATIONS & CONFERENCES

Twenty reports and papers have been published. Some of them have been presented at International Symposia /UNDP meetings. Two national conferences have been organised in 1982 & 1983. Fifth national conference in

electronics will be organised in 1984.

5.2. CARRIER TELEPHONE RESEARCH LABORATORIES, ISLAMABAD

These Research Laboratories were established in Islamabad with the help of Japanese Collaboration in 1981.

5.2.1. THE AREAS OF RESEARCH & DEVELOPMENT

(a) Telephone Laboratory

Development of High loss Telephone Set

Development of Push Button Telephone Set.

(b) Electronic Switching Laboratory

Study and development of Small Electric PABX

Study and Development of Small type ESS

Development of Auto Routiner.

(c) Carrier/PCM Laboratory

Study and Development of 3/6/12 CH TDM MUX

Study and Development of Carner Terminal equipment for Coaxial Transmission

Study and Development of Power Feed Equipment for Carrier

Study and Development of 30 Channel PCM System

Study and Development of Power Feed Equipment for PCM.

(d) Microwave Laboratory

Study and Development UHF Transceiver for 12 Channel TDM System

Study and Research in Microwave Propagation in Pakistan.

(e) VHF/UHF Laboratory

Study and Development of Single Channel VHF Systems

Study and Development of Mobile Telephone System.

(f) Data Communication/Computer Laboratory

Study and Development of MODEM

Study and Development of Mobile Telephone Systems

Study of Computer Application.

(g) Telegraph Communications Laboratory

Study and development of Voice Frequency

Telegraphy Terminal Equipment

Study and Development of Power Supply Units for various Applications.

(h) Circuit Component Laboratory

Production of Narrow Tolerance Resistors and Condensers

Development of Integrated Circuits.

5.2.2. STAFF

There will be total staff of 101 persons out of which about 90 will be professionals and sub-professionals.

5.2.3. FACILITIES

Electronic Switching Laboratory

Telephones instrumentation laboratory

PCM section

Microwave Laboratory

Telegraph communication laboratory

Circuit components laboratory

VHF/UHF Laboratory

Data Communication/Computer Laboratory

Anechoic room

Mechanical workshop

Testing chamber

Training office

Library.

5.3. SILICON TECHNOLOGY DEVELOPMENT CENTRE, ISLAMABAD

In order to acquire a foothold in the area of this technology a research and development centre known as silicon technology development centre has been set up in Islamabad since April, 1981,with the assitance from the United Nations and the Government of Pakistan.

5.3.1. OBJECTIVES

The objectives of this Centre are the transfer of Silicon Technology and acquisition of indigenous

skills, information and research and production facilities to support the development of silicon micro-chips, silicon semi-conductor electronics devices and solar cell technologies in the country, by assisting and advising the government has appropriate industries through its institutional and research and development activities.

5.3.2. PROPOSED INITIAL FACILITIES TO BE SET UP

The following facilities are being installed in the newly constructed building in H-9, Islamabad.

1. Extraction of poly-silicon from quartz or pure silicon sands locally available.
2. Purification of the extracted silicon to solar grade and micro-chip purities.
3. Growth, doping, cutting, and grinding of single crystal wafers to produce P V cells and solid state devices.
4. Develop the other routes of Silicon Technology such as " Ribbon Technology" Polycrystalline, Heterojunction and Amorphous Silicon Technology.
5. Installation of Pilot Plants for the Guidance and assistance of the industrial investors.

5.4. INSTITUTE OF ELECTRONICS, LAHORE

With the donation from local philanthropists and a donation from the Bank of Commerce and Credit International and amount of $ 3.0 Million was generated to set up an R&D Institute in Electronics at Lahore in 1983. The present Professional manpower strength is 10 Engineers with appropriate technical and administrative staff and the research and development areas are Computer Hardware/ Software, Industrial electronics, custom built products etc. However, the major emphasis is on development of application software for various dedicated computer applications.

5.5 INTERNATIONAL CENTRE FOR SCIENCE TECHNOLOGY DEVELOPMENT, KARACHI

Philanthropists from Karachi have set up this Centre in 1982 and they organized an international conference on microelectronics in the same year. The formal charter of this institute is in the final stage and fullyfledged work will start in 1984. The R and D work will be in microelectronics technology. There is also a possibility of setting up an industrial unit in microelectronics technology under this organization.

5.6. UNIVERSITIES & OTHER GOVERNMENT AGENCIES

The Electronics and Computer Science department

of Engineering University Hyderabad, Sind University Hyderabad, National College of Engineering Karachi, Quaid-e-Azam University Islamabad are undertaking the R&D work in application of microelectronics products Development of hardware and software in computer technology is one of the major areas.

There are a number of Government Organizations Autonomous Bodies which are conducting R&D in micro-electronic technology appropriate to their departmental needs.

5.7. REGIONAL COOPERATION

Pakistan would be interested in regional cooperation of the following:-

1. Collaborative projects in design of integrated circuits
2. Fabrication of integrated circuit
3. Computer aided design
4. Computer aided manufacture
5. Computer aided engineering of systems
6. Training in the above said field for Pakistanis
7. Accepting trainees in the field where we have technical know-how or active R&D work in microelectronics technology, with the permission of Pakistan Government.

6. NATIONAL APPROACH TOWARDS THE ACQUISITION OF MICROELECTRONICS TECHNOLOGY

The Government of Pakistan has given very high priority to high technology areas, for development of the country. The high technology has been developed in advanced countries like USA, Western Europe, Eastern Europe,USSR, Japan, China etc. Therefore, the only option open for Pakistan is to get technology from these countries. The transfer of technology can be of two types.

6.1 TECHNOLOGY IMPORT

Pakistan has signed bilateral agreements with advanced countries for its socio economic benefits. The turn key projects have been provided under these arrangements. The professional and sub-professional manpower of Pakistan has been trained by the respective countries for the operation and maintenance of plants given under these agreements. The know-how and association of technical manpower of the recipient country at the design stage of the plant is never made a part of the agreement. Thus imported technology ventures are good enough for routine type of industry which has proven economic benefits.Generally the output of such ventures is for the local market and it is mainly import substitute. It is disadvantageous to the recipient country because of the obsolescence in technology. The field of electronics being

a rapidly changing industry due to advances in microelectronics, thus it is not advisable to get such industry under technology import policy.

6.2. TECHNOLOGY TRANSFER

As the term implies the idea is to accelerate the capabilities of developing countries in a particular field to the level of advanced countries or try to bridge the gap between the advanced and developing countries in that particular field. It is a noble cause and for the benefit of the humanity and it must be performed. The recipient countries have to make sure whether they have human resources for absorbing this technology and developing it to such an extent that fruitful results are obtained. Other important items are the industrial infrastructure in the country, availability of raw material and willingness of the advanced countries to transfer a technology whole-heartedly. Almost in all cases of technology transfer, partial success is achieved.

Almost in all technologies, some rate of obsolescence has been observed. In electronics technology, however, the rate of obsolescence is very fast and it can be of the order to 3 to 5 years. Considering this rate of obsolescence the developing countries have to be

very cautious about going into a particular area of electronics technology transfer. It is imperative that futuristic vision must be there for projects in electronics technology, otherwise by the time a transfer technology project becomes viable in the recipient country, an entire new technology may be coming up. The rate of obsolescence is best illustrated by the development of discrete semiconductors, integrated circuits, small scale integrated circuits (SSI) medium scale integrated circuits(MSI) large scale integrated circuits(LSI) very large scale integrated circuits (VLSI) and microprocessor etc., which has been seen in the last two decades. The present trend is to change silicon base of these circuits and look into III to V compounds as a possible base. The research in the field has shown that Gallium Arsenide(GaAs) is most appropriate and is very likely to partially replace silicon as a base for LSI/VLSI by 1985. It has been estimated that most of the defence equipment will be based on Gallium Arsenide (GaAs) material by 1990. Depending upon the proven production procedures, this material may also serve as a base for commercial products in the civil. Looking at this respect, it is necessary for developing countries to form R&D teams to develop a capability of absorbing technology in this field so that they can immediately adopt the new technology. It may be pointed out that developing countries

do not have human and financial resources to do research at the same pace as in the developed countries but surely they can make a start in certain high technology areas, so that they are capable of absorbing and modernizing the electronics technology in the country.

In general, instruments and system is quite feasible in most of the developing countries for local use and export provided the products are competitive and innovative. Even in Asia, countries like the Republic of Korea, Taiwan Province, Singapore, the area of Hong Kong, and India have shown this capacity. The best example which can be quoted is Japan which started in the same way as most of the developing countries, just after world war II and due to futuristic vision of the planners in Japan, it has made tremendous strides in innovative technology, its products are not only competitive for sale in the world but also it has evolved new technologies for adoption specially in 1970s.

6.3. In order to acquire technological know-how training of professional manpower and establishment of industrial infrastructure, the government of Pakistan has evolved the idea of export processing zone industry. A number of such industries has been sanctioned(Table-8) and many more are in the pipeline for sanctioning.

TABLE 8

ELECTRONICS INDUSTRIES SANCTIONED IN EXPORT PROCESSING ZONE

S.N.	Name & Address of th Company/Firm.	Type of Electronic Products.	Expected Export $ Milln.	Domestic Value added $ Million	No.of Emp.	Expected Production Programme.
1.	Trans Tech. Corporation. Mr. Pervez Salim, 13346 Ronnie way Saratoga CA 15070 U.S.A.	Assembly of electronic eqpt.& Comp. device.	1.02	0.11	800	
2.	Macks Int.Electronics Co. Mr.Najeeb-ur-Rehman,1732 lamplighter lone los Vegas NV 89104, U.S.A.	Assembly VCRs, TV,VTR,Tapes.	0.2	0.035	100	Sept'84
3.	Ibrahim Electronic Corp. No.41 A President Shopping Centre,Serangeon Road Singapore -0821	Electrical & Electronic Products.	o.347	0.153	95	Oct'1983
4.	National Comprint Communication Ltd, A.R.Migule Chemical Engg. Services D-8700 reibarg, Habrbusestrable 129, West Germany.	Assembly of Communication equipment.	0.179	0.026	27	July 1985

5. Gulf Electronics Ltd.M/s Zubardi Enterprises,P.O Box 10139. Dubai U.A.E.	Mic.Computers,TV, Video,Cassettes.	0.179	0.026	27	March 1983
6. Famous(Intern)Printers, Dr. Sakina Khalidi,P.O.2601 Florida,33952 U.A.E.	Computer Forms/Cards.	0.241	0.238	61	July 1985
7. Gentlemen Electronic,Watches & Jewellery Industries, Mr. A.Aziz,P.O 682,Makkah, Asudi Arabia.	Electronic Watches.	0.278	0.103	80	Jan' 1986.
8. M/s.Progressive Corp. Mr. Zafar Iqbal, Block A, 7th Floors,Wing Fat Mansion NP, 23, Austrin Road, Kowloon, Hong Kong.	"	0.224	0.043	33	March' 1985
9. Ali Enterprises, Mr. Sikandar Ali, P.O. Box 1975, Dubai U.A.E.	"	0.13	0.09	20	Sept' 1985

7. MAIN FOREIGN SUPPLIERS OF MICROELECTRONICS TECHNOLOGY AND EQUIPMENT WITH SPECIAL ATTENTION TO REGIONAL RESOURCES

The microelectronic technology and equipment has mostly been imported from USA, Western Europe and Japan. In the field of computers there are over 100 medium and large size general purpose computers in use in the public and private sector organizations of Pakistan as per following distribution:

- Public Sector 58
- Private Sector 44
- Total 102

The Computers are being employed in the following applications:-

- Accounting
- Financial management and budgeting
- Record keeping
- Statistical analysis
- Tax evaluation
- Customs appraisal
- Personnel management
- Processing of Reports and Returns
- Monitoring of Development Schemes

- Compilation of data on industrial/agricultural production, trade, energy etc.
- Customer billing e.g. WAPDA, Sui Gas, T&T Department
- Management information systems
- Quality control
- Production/Stock Control
- Scheduling and Distribution
- Research
- On-line banking
- Engineering Design.

The use of computers is expected to grow at a faster pace. The projected requirements of usage of large and medium computer and an outlay for large and medium computer has been shown in **Figures** 1 **and** 2 respectively.

The main venders of these computer are as under:

TABLE 8

SUPPLIERS OF COMPUTERS IN PAKISTAN

Manufacturers	Nos.	Percentage
IBM	60	58.8
ICL	19	18.6
NCR	17	16.6

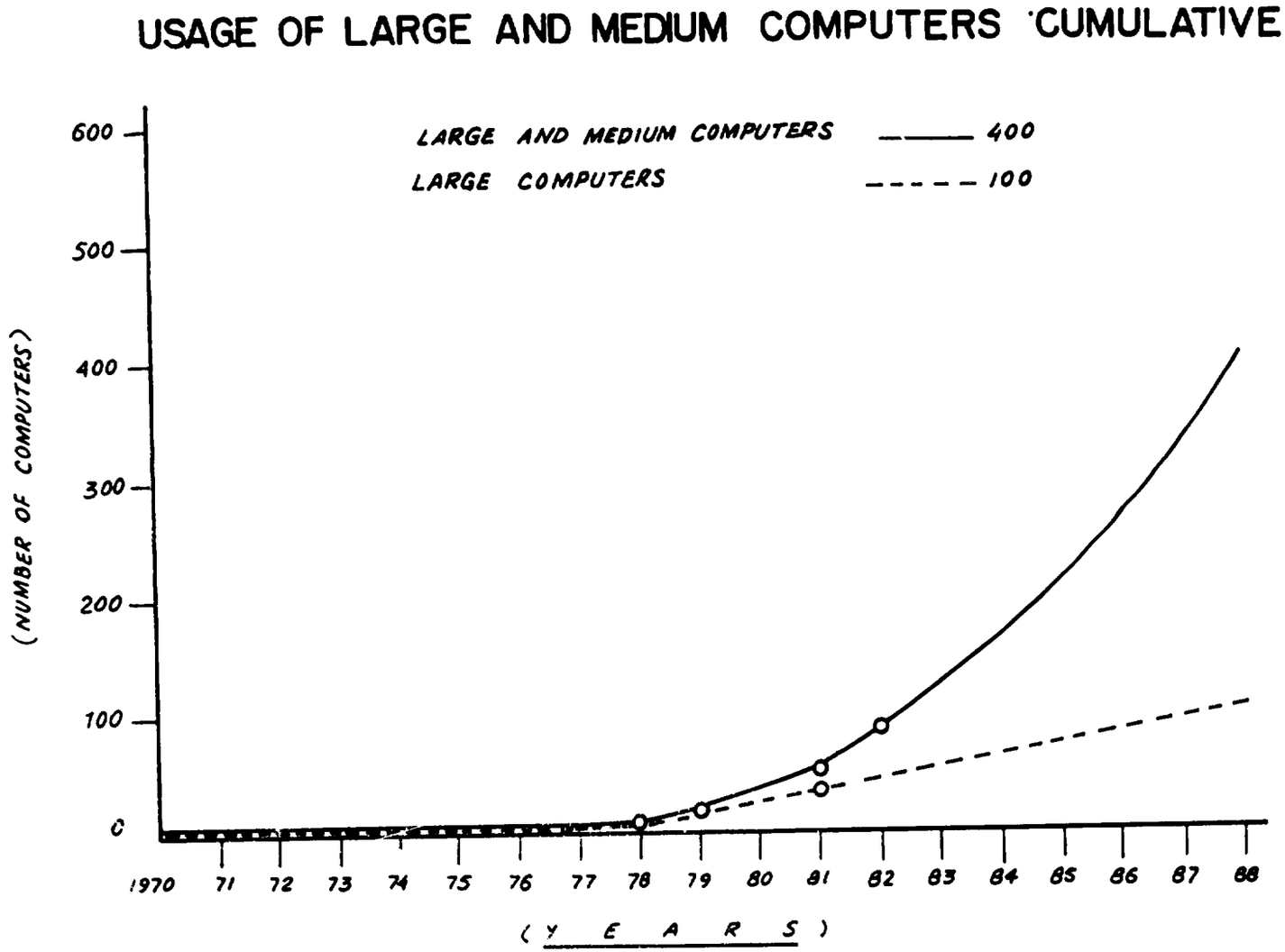
USAGE OF LARGE AND MEDIUM COMPUTERS CUMULATIVE
LARGE AND MEDIUM COMPUTERS 400
LARGE COMPUTERS 100
600
500
400
300
200
100
0
(NUMBER OF COMPUTERS)
1970 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88
(Y E A R S)

Figure 1

OUTLAY ON LARGE AND MEDIUM COMPUTER

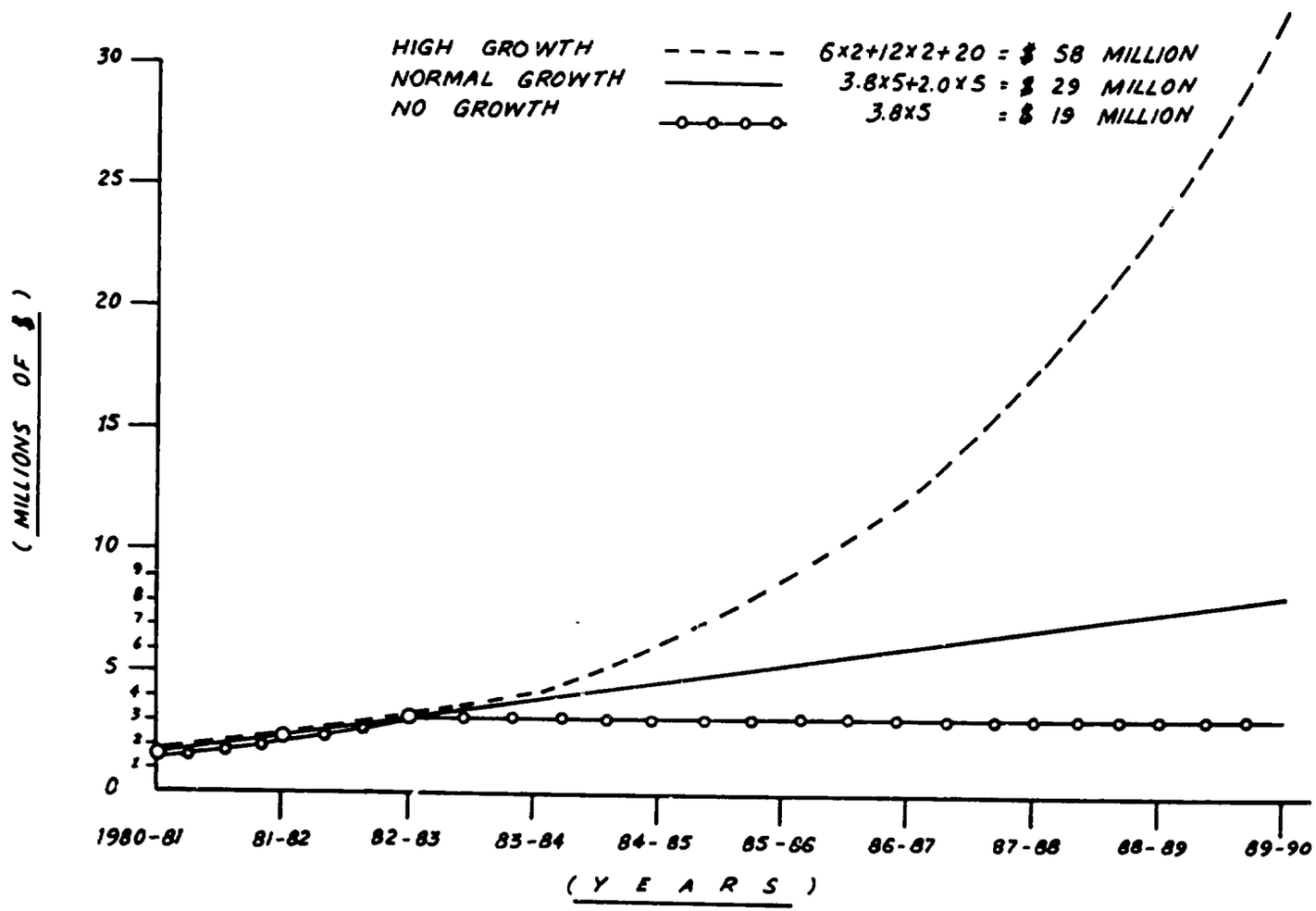

Figure 2

Others	6	5.9
Total	102	100

The import of computers for general use will increase. Recently the Government put all types of computers on the free list. Duty free import of computer is up to C and F value of $ 2255.00 and reduction in duty on tapes from 120% to 60% has been announced.

Exact data regarding microcomputers cannot be given since most of them are on the free list. However, an estimated figure is about 2 thousand microcomputers in use in Pakistan. Most of them Apple/Apple-2, Sinclair and other versions.

As far as the regional resources are concerned there is no bar for importing quality products from within the region. The products from Japan, the province of Hong Kong, the Republic of Korea, and Singapore are finding wider acceptance in Pakistan. Other Asian countries are catching up.

8. MANPOWER PROBLEMS IN MICROELECTRONICS INDUSTRY AND TRAINING EFFORTS UNDERTAKEN (e.g. BY SUPPLIERS OF TECHNOLOGY AND BY LOCAL INSTITUTIONS AND ENTERPRISES)

There are 24 Universities in Pakistan which produce professional manpower in social sciences, scientific and engineering disciplines. As micro-electronics is a multidisciplinary effort, therefore, the professionals which are required should have a degree in electronics, Physics, Chemistry, Chemical Engineering, Mechanical Engineering, Metallurgy and other allied subjects. The qualified manpower in allied subjects is in abundance, therefore, attention will be focussed on Electronics Engineering Graduates and M.Sc Physics with special paper in Electronics which are the entry qualifications in any electronic industry/R and D in this country. The manpower for computer technology will also be covered. In the previous years universities and polytechnics have been producing 400 professionals and 300 sub-professionals per year starting from 1978.

8.1. Instead of writing a detailed data for all the institutions, the enrolment of 1983-84 session of various establishments is the basis for data. The relevant figures are as below:

	UNIVERSITY/ESTABLISHMENT	DEGREE	ENROLEMENT 1983-84
1.	Engineering University,Lahore	B.Sc.Engg.	60
2.	Engineering University,Lahore (Taxila Campus)	"	15
3.	NWFP Engineering University, Peshawar.	"	20
4.	Mehran Engineering University, Jamshoro, Sind.	"	20
5.	National College of Engineering, Karachi.	"	150
6.	Punjab University, Lahore	M.Sc.in Physics with special paper in electronics.	60
7.	Quaid-a-Azam University, Islamabad(Computer Science Department).	M.Sc.in Computer Science.	25
8.	Quaid-a-Azam University, Islamabad(Physics Deptt.)	M.Sc in Electronics.	15
9.	Engineering University,Lahore (Computer Science)	Computer Science.	10
10.	University of Sind(Institute of Physics and Technology)	B.Sc. (Hons) Electronics.	40
		M.Sc(Hons)Elect.	12
		M.Sc Computer Technology.	18
11.	Peshawar University.	M.Sc.Physics with special paper in electronics.	10
12.	Karachi University	"	20
13.	NED University , Karachi.	"	25
			500

As regards the sub-professional manpower, there are about 35 polytechnics in the country which produce technicians in various engineering disciplines. Although mechanical metallurgical, electrical and other allied disciplines are also relevant but data on Polytechnic Diploma Holders in electronics and TV Technology will be given. The candidates who qualify for a three year diploma from such Polytechnics in Radio Electronics, TV technology are approximately 300 per year while the candidates having 2 years certificate course as a technician are approximately 200 per year.

There are about 1000 Engineers/Scientists working in the field of electronics technology in overseas countries and the bulk of them are specialists in their fields and they would like to come back to Pakistan for permanent settlement. There are also about 2000 technicians working abroad who are waiting for suitable jobs to come back to Pakistan and settle down in such jobs which provide job satisfaction. From the above data it can be seen that sufficient manpower is available to undertake any electronic ventures in the country.

8.2 DIPLOMAS/CERTIFICATES AND NON-DEGREE COURSES

Apart from the degree courses there are a number of institutes which run training courses on microelectronic technology and use of computers and these are listed here.

8.2.1. COMPUTER TRAINING CENTRE, ISLAMABAD

The Computer Training Centre was established at the University Grants Commission Campus in August 1982 under the aegis of the Centre of Basic Sciences, a consortium of the University Grants Commission and Government-run R&D organization.

Effective Utilization of microcomputers, mini-computers and the integration of microprocessors in intelligent automated equipment and industrial systems requires an understanding of computers beyond the mere knowledge of programming. An in-depth understanding of computer architecture operating system software, hard-ware interfacing is required for properly assimilating, adopting and adapting computer technology to solve problems faced in the country, an integrated hardware cum software knowledge base in digital/processor logic, computer organization, operating system and software engineering and in the theory of computing. The emphasis

in computer education needs to be "learning by doing" i.e. class-room training should be complemented by "hands-on" training in the laboratory on micrcsand minis.

FACILITIES

- Ten single board computer(SBC 86/12A)workstations, incorporating the 16-bit Intel 8086microprocessor

- Ten workstations comprising system S-500 8086/8087 based microcomputer systems with 256 Kbyte main memory and a 1 Mbyte 8" floppy disc drive and a video-terminal

- An Intel 287FD Microprocessor Development System with a hardware in-circuit emulator and PROM Programmer

- Digital equipment Corporation(DEC)'s PDP-11/23 Computer System with 256 Kbyte Main Memory

- A 16-bit 8086/8087 based al-M16 microcomputer with 512 Kbyte main memory, 8 Mbyte Winchester fixed media disc drive and 1 Mbyte 8" floppy disc drive with two colour graphics video terminals and a colour plotter.

- Robotics; three(3) Heathkit Hero-1 robots provide the lab environment for an introductory course in Robotics

- Dolch 48 - Channel Logic Analyzer
- A sinclair ZX-81 personal computer
- Hewlett-Packard video-course on Digital Logic.
- Video Cassettes of the lectures delivered at CTC's College on Microprocessors held in March 1983

- The VAX-11/730 has been ordered and is expected to be in operation in the first quarter of 1984

- It is also planned to acquire the Bell Labs popular operating system UNIX with C language for both of VAX and PDP-11 Computers

- The VAX-11/730 will be used for hardware maintenance training as well as for training in operating systems, compilers and for programming courses

- To provide remote computing facilities for the educational institutions within the Islamabad area, a data communication network for the Universities, based on the VAX-11/780 computer system is planned. An order for this system will be placed by end 1983 with delivery expected in the 2nd quarter of 1984

8.2.2. PAKISTAN COMPUTER BUREAU

- Computer orientation courses for senior officers
- Programming courses
- System analysis and design courses

8.2.3 QUAID-E-AZAM UNIVERSITY, ISLAMABAD

- Diploma in Computer Science/Programming languages

8.2.4 INSTITUTE OF BUSINESS ADMINISTRATION, KARACHI

Diploma courses on programming/data processing/ computer science and M.Sc. courses in computer science

8.2.5. DEFENCE COMPUTER INSTALLATIONS

Run courses on programming/data processing

8.2.6. USER ORGANIZATIONS

Course on programming/data processing

8.2.7. PRIVATE COMPUTER INSTITUTES

Courses on programming 6 to 12 weeks duration

8.2.8. NATIONAL INSTITUTE OF ELECTRONICS, ISLAMABAD

- Digital Electronics Course - 4 months duration
- Operation and maintenance training on Microprocessor development system HP 64000

8.2.9. COMPUTER SOCIETY OF PAKISTAN

AIMS AND OBJECTIVES

(a) To provide an organization for the welfare and professional advancement of personnel engaged in the professions related to computer science and electronic data processing in Pakistan;

(b) To promote knowledge of the development and use of electronic data processing equipment and techniques related thereto;

(c) To provide facilities for exchange of information and views on EDP equipment and techniques by holding and participating in conferences, seminars, conventions, and

lectures,and publishing newsletters and journals etc.

(d) To foster and encourage high standards of professional ethics and conduct among its members;

(e) To prescribe professional qualifications and to organize and conduct examinations for members and others in the field of computer science and technology;

(f) To establish a library and to collect equipment for the use of its members, for the promotion of knowledge of computer science and technology;

(g) To purchase, manage, lease, rent, hold, mortgage, sell, dispose of or otherwise deal with all or part of any buildings or other property, real or personal, or as may be deemed expedient with a view to the promotion of the above objectives, or of any of them;

(h) To borrow or raise any money that may be required upon such terms as may be deemed advisable;

(i) To affiliate, and/or cooperate with institutions having objectives similar to those of the Society in or outside Pakistan;

(j) To inform public opinion on the subjects listed above;

(k) To do all such other lawful things as are incidental or conducive to the attainment of the aims and objectives of the society.

ACTIVITIES

- Regular issue of the Computer News each month.
- Achieving professional affiliation with one of the leading professional bodies in the world - The British Computer Society
- Holding of Computer Exhibition on annual basis
- Organizing open days for students at various computer installations
- Organizing lectures and training programmes
- Constituting Chapters in Saudi Arabia, Kuwait, Abu-Dhabi, Bahrain, Dubai and London to enable our Pakistani colleagues working in these countries to

maintain effective links with their mother countries.

8.3. HARDWARE/SOFTWARE DEVELOPMENT

Software presently constitutes about 70 per cent of the cost of a computer system. Software development is labour intensive. This can be produced locally much more economically than in developed countries due to low cost of layout. Software development in the country should also be promoted through fiscal incentives. This will enable not only the development of software for local applications but also for export. Software development being a labour intensive activity, there is considerable potential in the country for the economic production of software for export at competitive prices. There are 28 software houses in the country providing application software to customers.

8.4. MANPOWER IN ELECTRONICS INDUSTRIES IN PAKISTAN

Public Sector and Private Sector Industries have been covered in Chapter 3 and 9. The likely investment in electronics industry is covered in Chapter 3 and electronic industry in export processing zone has been covered in Chapter 6. The existing

manpower for the established industries and expected manpower (star marked) for proposed/sanctioned electronics industry is given in Table 9.

TABLE 9

MANPOWER IN ELECTRONICS INDUSTRY

S.NO.	INDUSTRIES	MANPOWER
1.	Public Sector Industries (Reference Chapter 3 page 28)	4900
2.	Private Sector Industries (Reference Chapter 3 page 27)	1600
3.	Microelectronics Industries	250
4.	The proposed electronic Industries in the sixth plan period in private sector (Reference Chapter 3 page 33&35)	* 2000
5.	Electronic Industry in export processing zone sanctioned uptodate (Reference Chapter 6 page 60)	* 1250
		10,000

As the manpower is produced locally, the electronic industry is not likely to suffer from the availability of technical manpower in the sixth plan period or later on.

8.5. TRAINING PROGRAMMES BY SUPPLIERS OF FOREIGN TECHNOLOGY

The foreign Principals/their Representatives in Pakistan render after sale service for the products which have been sold. Naturally they have their own establishments for repair and maintenance works and therefore they train Pakistani Engineers to take up the maintenance/after sale service of their commodities. These training programmes are not open to other Engineers who are not their employees.

9. RAW MATERIALS AND EXISTING INFRASTRUCTURE FOR MICROELECTRONICS DEVELOPMENT

There are a number of requirements for fabrication of Microelectronic products. An outline of the requirements as well as existing microelectronic industries is described hereunder.

9.1. RAW MATERIALS & EQUIPMENTS

The raw materials required for microelectronic industry are as under:-

- Semiconductor grade silicon wafers
- Deionised water
- Photo resist materials
- Photo-litho-graphic materials
- Materials for masks
- High purity chemicals
- High purity metals & Alloys
- High purity gases
- Bonding materials
- Encapsulating materials etc
- Miscellaneous materials for use in semi-conductor technology.

Highly sophisticated equipment and clean room requirements are for any semiconductor manufacturing facility. Although it would be out of place to mention the details of equipment but equipment like furnaces, ion-plantation equipment, step and repeat camera, computer aided design equipment, microscopes, masks alligner, exhaust chambers etc. are required. Apart from that the test equipment, quality control equipment and reliability assurance test equipment are also required.

9.2. EXISTING INFRASTRUCTURE FOR MICROELECTRONICS DEVELOPMENT.

There are 4 industries producing microelectronics products in the country. One of them is in the the public sector and 3 of them are in the export processing zone.

The range of products and other pertinent details of these industries are as under:-

9.2.2. MICROELECTRONICS TECHNOLOGY LIMITED, LAHORE.

This industry was established in 1981 as a subsidiary of microelectronics technology incorporated Florida USA. The range of products of this company are:

Integrated circuits -- TTL series

Transceivers

Custom built ICs

Custom built equipment.

9.2.3. MICROELECTRONICS TECHNOLOGY LIMITED, KARACHI

This is also a subsidiary of M/s Micro-electronic Technology Incorporated Florida and the range of products being produced by this company are:

Car cassetts

Cordless telephones

Blood pressure measuring equipment

Video games

Custom built products.

9.2.4. ITAC FAUJI FACTORY, RAWALPINDI

This company is a collaborative venture between Fauji Foundation of Pakistan and Itac Incorporated USA. The factory was established in 1982 and it is producing the following range of products:

(a) 1. Video games Cartridge

2. Negative Ion generator

3. Truck computers

4. Tracking devices for vehicles
5. Push button telephones
6. Automatic recorders
7. Soft touch dialer.

(b) FUTURE PROGRAMMES

1. Custom built products
2. Custom built integrated circuits.

10. MAIN AREAS IN WHICH COUNTRY NEEDS COOPERATION AND CAN OFFER COOPERATION AT THE REGIONAL AND INTERNATIONAL LEVELS

Since electronic technology is rapidly expanding in quality and quantity, therefore, a regional/international collaboration in this activity can be useful for the donor country as well as the recipient country. Of course sharing of facilities, R&D collaboration programme, transfer of technology etc. have to be with the mutual agreement of the Governments of the countries concerned. Some broad areas can be defined where possibilities of benefiting from each other's experience exist.

10.1. The following fields are identified where Pakistan can impart education/training.

1. Education : Degree level courses in electronics at various Universities of Pakistan.

2. M.Sc Computer science/Engineering at Quaid-e-Azam University Islamabad, Engineering University Lahore and University of Sind, Hyderabad.

3. Diploma/Certificates type of Courses as outlined in Chapter 8.

4. R&D collaboration in component technology computer hardware/software with National Institute of Electronics Islamabad.

10.2. Areas of cooperation which Pakistan would like to take advantage of are defined as under:

1. Dedicated use of computers
2. Application software
3. Informatics
4. Automation
5. Equipment/System Design
6. Computer aided engineering
7. Computer aided design
8. Computer aided manufacturing
9. Fiber Optics technology
10. LSI,VLSI, design and fabrication technology
11. Higher education
12. On the job training in the advanced countries in the field of microelectronics technology

13. Robotics

14. Advanced electronic devices

15. Collaborative R&D Programmes.

BIBLIOGRAPHY

1. Aslam, M. Dr. The present status of Electronics in Pakistan. Proceedings of First National Conference on Electronics, Islamabad, Pakistan,March,1979.

2. Khan,M.Y. et al. Projected requirements of Electronics Industry, June, 1980. Prepared for Planning Division, Government of Pakistan.

3. Aslam, M. Dr. Implications of Microelectronics in Developing Countries. Presented at the Expert Group Meeting on the Implication of Technological Advances in Microelectronics for Developing Countries organized by UNIDO, Vienna, Austria, June,1981.

4. Hussain, M.S.Regional Study of the Electronics Industry August,1981. Prepared for Economic and Social Commission for Asia and Pacific (ESCAP) Bangkok,Thailand.

5. Aslam, M. Dr. Electronics Effort in Pakistan (a country paper). Presented at a Seminar on the Development of Electronics Industry in Thailand and

in ESCAP region. Organized by ESCAP, Bangkok, Thailand, November 1981.

6. Export Processing Zone leaflets. Published by Export Processing Zone Authority, Government of Pakistan, Karachi.

7. Computer Journal, Computer Society of Pakistan, Karachi, April,1983.

8. Aslam, M. Dr. Electronics Technology transfer for Pakistan (Also published in AEU Journal Japan Jan.1983) Presented at Symposium on Microelectronics and Communication New Dehli, India, April 1983.

9. The sixth five year plan(1983-88) published by the Planning Commission, Government of Pakistan,1983.

10. Electronics Design International Jan.12,1984, published by Hayden Publishing Co.U.S.A.


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