EXECUTIVE SUMMARY

1. The Computer Peripherals can be classified as Input, Output and Input/Output (I/O) devices:

Input Devices : Key boards, digitizers, card readers, tape readers and pointing devices e.g. mouse, light pen.

Output Devices : Printers (Impact and non-impact), plotters, monitors.

Input/Output Devices : Terminals, auxillary memory devices e.g. tape drives, disk drives, floppy drives.

2. The growth and development of the peripheral industry is directly linked with the parent computer industry on the one hand and components industry on the other. The demand for peripherals is directly derived from the present installed base and the growth of the computer industry, which would determine the demand in future. The supply, particularly through the indigenous manufacture is however, largely dependent on the indigenous base of the components industry.

3. The annual growth rate of the electronics industry has been over 30%. However, the computer industry has shown a significant development in India only in the recent past after the policy of liberalisation of imports was introduced in 1984. The share of the data processing segment, which includes computers and computer peripherals, has been only around 8% of the total value of the electronic production. The contribution of the computer peripherals to the total production in computer industry was about 12%, 15% and 20% (approx) in 1986, 1987 and 1988 respectively. The total turnover of the peripheral industry was Rs. 31.4 crores and Rs. 54.5 crores in 1986 and 1987 respectively.

4. In computer system, the peripheral items/products account for about 60-70% of the total value while the domestic peripheral industry accounts for only about 20% of the total computer industry production. The balance requirement is met through imports either directly or along with imports of computer systems.

5. A significant consequence of the growth in computer industry has been a substantial fall in the prices, largely due to technological advancements which make computers available at lower prices. Another reason for this is the various steps taken to promote the industry. The growth, in purely physical terms, therefore, has been much higher.

6. There are over 150 units operating in the field of computers out of which more than 100 are in small scale sector. The small sector contributes about 38% in the overall electronic production. These units manufacture a variety of items like mini/micro systems, PCs, peripherals, data acquisition systems and other micro-processor based systems.

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7.   Over 110 licences/letter of intents have been issued to various Indian units for manufacturing computer peripherals. There are,however, only about 25 to 30 major peripheral manufacturers in India, both in large and small scale sector.

8.   The predominant method of acquisition of peripheral technology by the Indian manufacturers has been the licencing arrangements. These arrangements emphasize on a fixed initial price (lumpsum fee) of technology with a stream of fees in the form of royalty that are generally based on sales over a period of time. Out of over 65 foreign tie-ups approved, only about 32 foreign collaborations are in various stages of implementation.

9.   Currently the following peripherals are being manufactured in India :

    i)   Dot Matrix Printers
    ii)   Line Printers/Daisy Wheel Printers
    iii)   Floppy Disc Drives Hard Disc Drives
    iv)   Cartridge Tape Drives (CTD)
    v)   Terminals, Monitors and Key Boards
    vi)   Plotters and Digitizers
    vii)   Magnetic Ink Character Recognisers (MICR)

       The peripheral items like non-impact printers using thermal, ink-jet, ion-deposition and laser technologies and optical disk drives have not been attempted by Indian manufacturers. Hard disc drives of Winchester technology are of recent origin in India. The SSI units are engaged primarily in the manufacture of monitors, terminals and key board. Only one unit namely, Digital Electronics Ltd is engaged in the manufacture of plotters and digitizers.

10.   The actual production value for 1986 and 1987 in the major peripheral categories is :

Item	1986 (Rs.millions)	1987 (Rs.millions)
Printers	54	202
Terminals	140	200
Drives	54	41
Others	66	102

       The estimates of production quantities under major peripheral categories for the year 1988 is :

Item	Production (Nos)
Monitors	46,000
DOT Matrix Printers	26,450
Floppy Disk Drives	58,100

       As per information provided in the Annual Report of DOE, the production of computer peripherals was Rs.65 crores in 1988 and Rs.130 crores in 1989.

11. The manufacture of peripherals involves the assembly and sub-assemblies of components :

- Plastic components
- Electronic components/assemblies
- Electrical, Mechanical/Electro-mechnical components.

a) The manufacture of plastic components like monitor castings, keyboard etc. involve design and preparation of dies and injection moulding technology. The capital investment required is very high in these cases due to the high precision and styling intricacies involved in plastic components for peripherals.

b) Manufacture of electronic sub-assemblies/ assemblies involves following steps :

- Manufacture of printed circuit boards
- Assembling components on to PCB
- Testing and Inspection

c) Manufacture of mechanical components and parts like metal chassis for monitors, keyboards, key plates, many metal chassis components in peripherals etc; involves use of various production processes such as sheet metal, forging, turning, grinding, electroplating, finishing etc.

d) The electro-mechanical components involve the production of both electrical and mechanical components followed by their integration. These components include items such as micro-motors, relays, actuators, coils, magnetic heads etc. These items involve high precision engineering, tooling and manufacturing technologies for ensuring the required performance levels. Most of these components are currently imported as the manufacturers do not find the performance and reliability of indigenously made parts satisfactory. Besides, they are costlier. A few units, however, have set up manufacturing facilities for magnetic read/write heads e.g. Tandon (Golden Computer) located in SEEPZ and MIT Chandigarh. An upcoming company, TVSE, also has plans to set up facilities to manufacture some of these items in-house.

12. The manufacture of electronic components is a seperate industry in itself. Their manufacture is a conglomeration of various technological processes viz. chemical, mechanical, metallurgical and precision assembly etc. The production of most of the professional grade components is very limited because they are material intensive and require imported electronic grade materials. These materials include silicon, gallium arsenide, display tube phosphores, thick-film material, gamma ferric oxide, plastic, chemicals and gas photomask materials, metals and ceramics. Indian efforts in vital raw material production is very weak so far and, therefore, the manufacturers resort to imports.

13.   An important feature of the computer peripherals is that the original manufacturers or the collobarators ensure the uniqueness about their product through the use of proprietary components necessitating continued dependence on collaborators for their supply.

14.   The developments in peripherals are aimed at increasing compactness/ miniaturisation and speed of these devices besides improving the price/performance ratio.

15.   The thrust is shifting on development of the non-impact printers like thermal transfer, ink-jet printers, electron-photography printers. In impact- printers, The efforts are directed at improving the performance and reliability of wire dot matrix printers to provide compactness, high speed, low price and low noise apart from additional funtions of graphic printing, colour printing etc. In order to get better resolution and print quality, attention is being focussed on 24 pin print heads. The resolution has been improved by smaller dot size, greater dot density and improved firmware control. Special super-hard metal alloys have been developed to manufacture pins or dot-wires which will overcome the problems of low break resistance due to use of the small dot size wires.

16.   The non-impact printers using thermal transfer technology presently offer superior quality printing only on papers with smooth surface. Efforts are being made to improve the print quality on course grade papers. R&D efforts are also underway to increase the printing speeds. Thermal printers with speeds upto 450 cps and a column size of 272 columns have also been developed.

17.   Full colour non-impact printers using ink-jet technology have been developed with area gradation capabilities. Efforts are directed at overcoming the inherent problems like ink clogging, low reliability and special paper requirements. The demand for these printers is, however, expected to increase due to low price and colour capabilities despite the shortcomings.

18.   In laser printers, the R&D efforts are directed at incorporating features like multiple font capability, ability to mix text with bit mapped graphics, feasibility of combining it with image processing technology, development of high resolution colour printing process and lowering the price. Typically, the resolution is 300 dpi and speed is upto 24 pages/minute.

19.   The auxillary memory devices have been witnessing rapid technological innovations in terms of increasing compactness, memory capacity and improving access time besides reliability. In recent past, the originally introduced floppy disk drive technology has witnessed the emergence of Winchester disk technology, Optical storage technologies, Magneto - Optic storage technology, a combination of magentic disk and optical technologies. In add-on memory devices, Hard Cards using magnetic, optical and IC technologies have been developed.

20. As far as the disk size is concerned, the 5 1/4 inch drives currently dominate the market. Of late, Winchester disk drives, 3 1/2 inch and 2 1/2 inches in size have also been introduced. With their lower power consumption, reduced weight and size, micro-winchesters are being used in portable computers.

21. Magnetic disk drives of higher capacities viz. 80 MB, 120 MB. to 660 MB and more have been introduced for use in PC -ATs and mini computers. The Optical disks, based on laser technology, can store data upto 600 to 1000 MB on-line and have virtually a limitless life span as the head is not in contact with the disk surface.

22. Technological advancements in achieving faster access times have also taken place alongside the increase in memory capacity and reduction in size.

a) Access times as low as 10.7 ms have been achieved in Winchester disk drive due to lower weight of actuating arm, R/W head besides reduction in disk size, surface to R/W head gap, higher track densities and more efficient R/W head mechanism.

b) The emerging trends in the disk drive technologies are:

i) Use of thin film technology for storage media has started taking place. Through the use of these media, magnetic disk drives of about 2" are forecasted to penetrate in further miniaturisation. Recently, 3 1/2 inch drives have been introduced using thin film heads instead of conventional ferrite heads. As for performance, a low mass and straight arm allows the drive to achieve an average access time of 16.5 ms.

ii) Use of the vertical recording technology as a new magnetic memory technology for increased capacity by achieving greater areal density with the same head/disk. The vertical recording technology uses the monopole approach wherein instead of inducing flux changes in the medium from an adjacent magnetic field, the head and the disk are a part of a single magnetic circuit whose gap is formed by the flying height of the head. The size of the magnetic domain and the density of the recording are determined by the +size of the tip of a very thin probe head. All lines of magnetic flux then pass through the probe into a two layer medium. The flux is so dispersed on its return path that it does not affect the upper recording layer.

iii) Use of the voice coil actuator technology in place of the stepper motor technology to improve access time and attain higher drive capacity.In conventional disk drives, the head moves across the platter one track at a time whereas the Voice Coil Actuator enables the movement of

the head across the platter nearly as quickly as they can move the heads across one track. A servo-control mechanism speeds up the head positioning precisely. Higher precision positioning also enables tracks to be packed more tightly on each platter for higher drive capacity.

iv) The evolution of standard test interface chip that would provide one place where a test device could get access to all the necessary signals on the drive without affecting the integrity of drive operation. This has been necessitated because of the advancements in manufacturing technology using surface - mounted components, resulting in compactness and double-sided PCBs. Without access to conventional test points, high level drive test has been reduced virtually to "go - no go" level. Efforts are currently being made to evolve a range of industry standard tests that will enable full testing of drives with standard interface chips.

v) Development of the Magneto - Optic disk technology. Currently, the use of Optical devices is limited to storage of archival information due to lack of erase or re-write facilities (CD ROM, WORM). Intensive R & D is aimed at improving reliability and access time of erasable recording technologies. In this category, the erasable magneto - optic disk is the most promising technology.

23. A greater need is felt for back up storage devices which ensure that the information being processed is not irretrievably lost due to factors such as power failure, voltage fluctuations and R/W head crash in drives.

There is a transition from conventional reel-to-reel tape units to compact, high performance Cartridge Tape Drives (CTD). Standardisation has emerged only in the quarter inch and half inch CTD categories represented by QIC and IBM 3480 respectively. An emerging development is the move to standardise half inch tape cartridge as the primary back up device for a range of computer systems. In mini-cartridge tape drives, the QIC-40 recording format specification was adopted by QIC standard group in 1986 as the industry standard. QIC-40 calls for 40 MB of data recorded on 20 tracks at 10,000 flux reversals per inch. It allows exchange of files on a variety of tapes without hampering compatibility. It is expected that the price/performance benefits of these products would encourage acceptance of the higher performance tape technology.

24. High resolution PC Monitors are among the key components computer manufacturers are using to enhance CAD graphics capabilities. CGA, EGA and VGA boards have been developed which offer high resolution capabilities. Even sharper graphics and increased colour capabilities are available with Super-EGA, Super-VGA boards and other very high resolution cards, some reaching 1280 x 1024 pixels. Some of the emerging trends in these peripherals are:

a)   Each graphic standard requires a different combination of horizontal and vertical scan rates. Multiscanning or multi-synch monitors have bee developed which can scan a range of horizontal and vertical frequencies and, therefore, support a wide range of graphic standards. They also offer a high degree of image control compared to analog monitors. Technology has also been developed making it possible for the multiscanning monitors to have auto-sizing capabilities, which does not require the horizontal and vertical image-size-controls on the monitor.

b)   Currently, the efforts are aimed at standardising the PC graphics with resolutions and colour capabilities higher than VGA. The aim of these efforts is to standardise the electrical timing and programming issues : horizontal timing, vertical refresh rate and mode. The predominant approaches emerging strongly in this direction are :

-   To add extended-resolution-modes to VGA type video controller, as adopted by Video Electronics Standards Association (VESA) and

-   To evolve standard around IBM's advanced 8514/A graphics-processor-based system.

These technologies involve use of Application Specific ICs (ASIC).

25.   As a consequence of PCs becoming compact and portable, the demand for flat panel displays has been increasing.

a)   Currently display using LCD technology are most popular and used widely for their low power consumption, easy print of colours and reasonable price. Displays using electro-luminescent or gas-plasma technology, on the other hand, require higher voltage and have the disadvantage of poor colour capability and higher price.

b)   In LCDs, efforts are directed towards enhancing their colour capabilities, display screen size and response time. LCD colour displays using double super-twist technology and active matrik technology have been developed. These make us of some RBG filters to create colour screen.

c)   The closest replacement to colour in Laptop Computers is gray scaling using display controller chip that selectively turns pixels 'on' and 'off', thus, creating different shades to represent different colours.

d)   A new technology namely Poly-vision technology using a chemical film technique is currently under development. This will achieve a high contrast image of near photographic quality besides increased response time and a possible writing rate of atleast 30 frames/Sec.

26.   Most of the companies with foreign collaborations are still in the various stages of implementation. It is, therefore, premature to pass a judgement on the full impact of the foreign collaborations on the technical capabilities and competence of the Indian peripheral industry. Most of the approved collaboration agreements include transfer of technical know-how pertaining to only the specific models of peripherals, their manufacturing, assembling and limited testing and servicing.

27.   Restricted transfer of technical know-how by foreign collaborators due to incorporation of the proprietary components and sub-assemblies in their products has made it difficult for the Indian manufacturers to carry their indigenisation efforts to the design level particularly, in view of the small R & D budgets and difficulty in availability of qualified and trained technical manpower. Also, little emphasis is given to the transfer of technical know-why.

28.   The Indian peripheral manufacturing technology is slowly graduating from its SKD/CKD level assembling phase towards real manufacturing replacing, thus, the old trading culture. The policies to discourage SKD/CKD level imports have also contributed significantly to bring about this change. This is specially true in case of some large manufacturing units with sound experience and background in engineering and electronic industries.

29.   Industry is still in the process of building up its R & D capabilities in the areas of know-how, technical manpower, etc. In majority of the cases, R & D is still at the level of replacement technology i.e. finding an indigenous substitution or equivalent component within specified tolerance limits which can be used in place of imported components.

30.   The existing level of indigenisation varies from one peripheral to another. It is indicated in the table given below by value (1987).

Item	Percent indigenous at domestic prices	Percent indigenous at import prices
Key Board	82.3%	65%
Monitors	75%	50%
Line Printers	71.2%	42.5%
Dot Matrix Printers	75%	50%
Floppy Disk Drives	33%	20%

31.   The Indian manufacturers have by and large confined themselves to manufacturing of products which are easier to manufacture where the technology is stabilised. Consequently, the level of indigenisation achieved in these products is higher. Efforts are being made to indigenise imported items like stepper motors. The manufacturers have been reluctant to venture into manufacturing of hard disk drives primarily because of rapid advancements taking place in storage technologies besides non-availability of basic technology. The existing manufacturers of floppy disk drives have also indigenised their products only to the extent it is easily possible.

The indigenisation efforts, however, have received set back due to emergence of three-and-a-half inch technology while the Indian manufacturers were still in the process of acquiring know-how for five-and-a-half inch floppy disk drives.

32.   The area where maximum indigenisation has been possible is in the manufacture of plastic and metal parts. In electronic sub-assemblies, most of the effort has been limited to replacement of imported components with the indigenous ones. These efforts, however, have met with only marginal success due to high cost and unsatisfactory performance of indigenous components in most cases. In case of electro-mechanical components and sub-assemblies, the manufacturers have found the indigenous vendors lacking in technical know-how in the areas of high precision engineering and tooling.

33.   Varying degree of gaps exist in the indigenous vis-a-vis state-of-the-art technologies.

a) The indigenous industry is still in the process of perfecting the skills and know-how for impact printing technologies and, therefore, lags behind in the state-of-the-art non-impact technologies namely laser technology, ink-jet technology, thermal technology, etc.

b) The gap is very large in the area of auxillary storage pheripheral technologies. The international trend is towards more compact and efficient three-and-a-half inch disk technologies, optical storage technologies, etc. Rapid advancements are still taking place in these technologies and ambitious R & D projects have been planned by international firms to acquire and/or retain the position of leadership in these technologies.

c) Technology gaps exist in the area of high resolution display technologies viz. LCD, Plasma, Polyvision, etc. These techniques used mostly in portable micro-computers, etc., have yet to make their presence in India though a few handy or hand-held terminals with LED/LCD types of displays are being marketed in the country.

d) Gaps also exist in areas of very high resolution graphic adapters, namely SVGA, etc; multi-synch or multiscanning monitor technologies and data communication terminals with sophisticated features like auto-sizing capabilities in the multi-synch, monitors etc.

e) The manufacture of cartridge tape drives, plotters and digitizers is only of more recent origin in Indian industry and, therefore, the level of indigenisation is still very low in these peripherals. Also, very few units have attempted their manufacture. The pointing devices like mouse, light pen, etc., have not been manufacturd so far.

34.   The manufacturing methods of peripherals in the developed western countries and Japan are characterised by the extensive and intensive use of automated processes and automatic assembly. This is not so in the Indian industry, through

a few units have installed and attempted semi-automatic methods of manufacture and testing on selective basis.

35.   The relevant issues like the availability and cost of capital equipments, cost of production, quality imperatives and international competitiveness need to be considered besides the demand for computer peripherals. With the advancements in robotics and flexible manufacturing technologies, the low wage, low labour cost are fast becoming insignificant factors.

36.   For industry to grow, a substantial amount of capital has to be brought in. The problem becomes more acute because of high investments required, uncertain demand projections, long gestation periods and very short product life cycles specially for certain products like storage devices. The Capital Goods involved, which are imported, for manufacture of peripherals include wave soldering machines, pneumatic lead wire cutting and trimming machines, CAD workstations, injection moulding machines, exercisers, automatic burn-in and testing equipments, colour pattern generators, precision die making machines, etc.

37.   The capital equipment industry for peripherals has to be examined in the overall framework of planned priorities, strategy for development of electronics industry as a whole, availability of scarce capital, etc. Since, the capital equipment industry for electronics has yet to come up in India, for the present, reducing costs in capital investments essentially entails reduction in customs duty.

38.   The manufacturing technology of peripherals is also directly linked to the state-of-the-art technologies for manufacture of components coponents which has an important bearing on the design, sub-assembly methods. Some of these significant technologies are:

-     **Surface Mounted Technology (SMT)** for high density component assembly

-     **Application Specific ICs (ASIC)** where the technology is that of design automation

39.   SMT represents the third phase in the evolution of electronics components technology. In the first phase, it was the hand solderable type which involved human labour for assembling components. These components needed to be electrically perfect. In the second phase, it was machine solderable to make use of automated asembling techniques, These components need to be perfect both electrically and mechanically. The current phase, based on SMT, requires much higher mechanical tolerances.

Besides being 30% to 60% smaller than the traditional leaded components, surface mount devices are faster, more reliable and cheaper to produce, It results in smaller end products, higher assembly speeds, much cheaper and more reliable end products. A significant side effect of SMT is the growth of double sided PCBs.

India is beginning to enter in second phase of component evolution, though many units specially in SSI sector are still in the first phase. SMT has been attempted only by a large companies on a limited scale. It is estimated that about 30% of equipments produced in USA is based on SMT. In Japan, it is over 70%.

40.   Among electronic components, the ASIC, which are incorporated into the design of peripherals, mostly as proprietary items by the foreign collaborators, are one of the important items of import besides other ICs. The major advantages of ASIC are:

-    Minimum chip size
-    Implementation of only functional circuittry
-    High level of design security
-    Decreasing level of board connection failures

ASIC for computer peripherals will have to continue to be imported till the indigenous industry develops adequate R & D capabilities, because the technology is basically that of design which itself is borrowed from the foreign collaborators. In other professional grade ICs (LSI, VLSI, etc.) also, the indigenous requirements are met through imports to a large extent.

41.   India still imports about two-third of its requirements of the professional grade electronics components. About 70 percent of the material inputs in components are also imported. These include : Germanium, Silicon, GaAs, CRT phosphores, thin film materials, Gamma ferric oxide, electronic grade chemicals and gases, high purity metals and alloys in different shapes and electronic ceramics.

42.   Besides gaps in raw material availability and technologies, two important factors that have inhibited the growth of the indigenous peripheral industry have been:

-    The lack of standardisation making it difficult to cater to the variety and small quantity requirements of peripherals
-    High price, sub-standard quality and low reliability of indigenous components

43.   The indigenous components are priced 50 to 150 percent higher than the imported components. The price difference occurs mainly because of the reasons given below:

-    Higher project cost due to delay in implementation and scale of production
-    Higher value of inventory because of higher cost of raw material due to larger lead time, high inventory levels, etc.
-    Lower degree of automation
-    Low scale of production

44. In case of the electro-mechanical and mechanical components, the gaps in the technical know-how and production expertise exist in the areas of low micron engineering and precision toolings and assembly.

45. Certain specific components imported for some of the peripherals are mentioned below :

a) In manufacture of printers, the various raw materials typically consist of print head, timing belt, stepper motor, photo sensors/photo cell, membrane/micro-switch and other discreet semi-conductor components, PCBs, LSIs, ink-ribbon assembly, gear mechanism, shaft, machined castings and plastic moulded parts e.g. cabinet. Major high value items like print head, timing belt, stepper motor, LSIC, micro-switch are imported.

b) In monitors, the typical raw material and components which are incorporated include data grade high resolution CRT, fly back transformer, deflection yoke, coils - hoz width and line coils, peaking coils, osc. coil, bi-polar capacitor, metal oxide resistors, high voltage/high current rectifiers. These are mostly imported . Other components are available indigenously and include electrolyte capacitors, potentiometers, rectifiers/diodes, PCB main transformer, misc. hardware, solder, cable, etc. In colour monitors the additional items of import include high frequency transformer, colour CRT filter besides CRT, EHT two-coil deflection components, etc.

c) Most of the items required for manufacture of disc drives are imported. These include read/write heads, stepper motor, micro motor, actuator, read/write circuitry, controller with micro-processor, etc.

46. Maintenance of computer peripherals is a highly specialised task requiring knowledge of both hardware and software. Industry today lacks adequately trained manpower and experienced technical manpower for product support besides cost-effective maintenance support methodologies.

Most of the peripheral manufacturers have also criticised the policy of higher import duties in case of the spares required for maintenance as against the lower duty for the same items when required for production. The users on the other hand, are faced with the problems of poor and costly maintenance, delays involved in import of spares besides high cost of maintaining an inventory of spares.

47. The decisions relating to choice and purchase of technology have to be consciously exercised. The technology policy/selection can be a complex issue and requires keeping a tab on the trends in state-of-the-art technologies and markets besides a realistic assessment of indigenous R&D capabilities.

The high rate of technological obsolescence of peripherals requires that :

a) the purchase of know-how should be properly timed keeping in view

the product life cycle of state-of-the-art technologies. Know-how costs are high in the initial phases of product life cycle with the associated risk of premature failure of the product. Towards the end of the product life cycle, though know-how costs are small, the price-performance will be higher than the new generation of products.

b) the start-up time for projects and the time involved in procuring imported raw materials, components, C.G., etc., should be minimised through efficient operations, computerisations and removal of procedural delays, etc.

c) A Technology Agency or Technology Watch Cell should be set up with representations from Government, industry, R&D institutions and academic institutions with a view to report on peripheral technology trends, indigenous capabilities and to identify the front-end/emerging technologies on a continuous basis.

To facilitate this, a technology information data bank, on the lines of on-line information data banks in developed countries, should be established. The Agency should also be required to estimate the efforts required to design and productionwise a particular product and assess the indigenous R&D capabilities.

48.   More emphasis should be provided on having foreign collaborations which will facilitate more effective transfer and upgradation of technology. The following measures may be helpful in this regard :

-    Focus on front line technologies

-    Effort to be made for obtaining 'know-how' as well as 'know-why' from the foreign collaborators

-    Extension of collaborations on selective basis in a manner that facilitates technology transfer.

49.   It is necessary to define 'viability' in the context of the emphasis on policy for indigenisation, indigenous demand for a product, export-competitiveness and the indigenous base of the component and sub-assembly manufacture.

Flexibility in allowing import of component generally ensures production of more State-of-the-Art products, whereas emphasis on use of indigenous components beyond a certain level may render the product uneconomical besides lagging behind the State-of-the-Art products.

Use of low quality, high priced domestic components would degrade the quality and increase the price of the end product. The enforcing of PMP in peripherals, can therefore, lead to a sharp increase in the price of end products

after a certain percentage of indigenisation which would vary from product to product. A flexible approach to PMP may be considered rather than a rigid enforcement of PMP, in appropriate cases.

An indepth study, therefore, should be conducted to analyse the prevailing cost structures of indigenous vis-a-vis imported products for various peripherals. For some products, e.g. winchester disk drives, laser printers, etc., this might mean only a small per cent of indigenisation at present.

50.   In the context of the scenario mentioned in the previous paragraph a workable definition of 'viability for manufacture' of Peripherals could be considered. One of the suggestions made in this regard, refers to the product is :

- it is upto a maximum of 2 to 2-1/2 years (maximum) behind the State-of-the-Art technology product abroad

- it does not costs more than 120% of its equivalent counterpart abroad (CIF)

- its quality is comparable to its counterpart abroad

- the level of indigenisation is 50% or above of the CIF value of equivalent counterpart or 70% or above of ex-factory value.

51.   Currently, therefore, the following Computer Peripherals are viable for domestic production :

- Dot Matrix Printers
- Line Printers/Daisy Wheel Printers
- Monitors and Key Boards
- Plotters, Digitizers and High Resolution Monitors
- Tape Cartridges
- Winchester Disk Drives
- Laser Printers

The non-impact printers based on thermal, ink-jet, ion-deposition, LCD/ LED technologies, high density micro disk drives and optical disk (particularly erasable types) are the technologies to be watched carefully in coming years for stabilisation in technology as well as growth in domestic demand. Their viability should be reviewed on an on-going basis.

52.   The economic level of production is inherently controlled by the dynamic factors of indigenisation levels and demand potential besides the level of technology itself. Setting a fixed value for economic levels of production under these dynamic parameters for computer peripherals, which characterise the technologies 'in-flux', may be counter-productive to the growth of the industry in the long run. Also, most of the manufacturing programmes are still in the initial phases of their collaborations and, therefore, it is premature to comment on the impact of these

collaborations on to the capabilities and competence of indigenous industry.

53. The policy of liberalisation should be continued. The policies should also aim at facilitating exit, merger and consolidation of firms to allow for restructuring of capacities. Healthy competition among indigenous manufacturers should be encouraged.

54. The effective protection to manufacturers should be reduced in a phased manner to encourage them to expand their market and to become internationally competitive.

55. Small manufacturers should be encouraged to serve as ancillaries to some big companies. This will encourage establishement of electronic services and infrastructure and other agglomeration economics.

56. The 'short life cycle' is a fact of computer peripheral products and industry, should therefore, encourage a culture for innovation in design and manufacture of new generation products. The Indian engineering skills should be fully utilised by providing more challenging jobs in design and manufacture. The trend of the technical manpower to drift towards managerial and sales jobs should be arrested.

57. The industry should consider setting up a few plants for manufacturing dies, moulds and good quality castings to meet its varied requirements. This will also reduce fragmentation of production capacities in these areas spread over a number of individual peripheral manufacturing units.

58. Vertical integration should be encouraged in setting up production facilities for manufacture of computer peripherals to take advantage of :

- the captive demand for components, sub-assemblies and even some end products.
- the comprehensive manufacturing, testing and R&D facilities.
- innovation in design and product features
- the scarce engineering and design skills
- production cost economies

This is particularly true in case of the large manufacturing houses that promise substantial export and cultivation of R&D to reduce foreign exchange drain for technical know-how.

59. Attempts should be made to avoid fragmentation and duplication in R&D efforts and investments. Thus, with the same amount of money, the present R&D effort can be strengthened to imbibe the latest technology. Given the low turnover in the industry the orientation towards, R&D efforts needs to be changed from

'R&D by all' to 'joint R&Ds'. Besides, R&D should focus on emerging technologies rathern than on reverse engineering of existing technologies.

60. R&D initiatives need to be taken up in some of the areas of emerging technologies. A planned entry in a few of these areas will help in achieving the long-term objectives of self-reliance. Some of these areas are flexible manufacturing and robotics, surface mounting technology, application specific ICs, optical storage technologies, high resolution display technologies. The R& D application need to be multi-disciplinary and highly integrated. Some important disciplines include magnetics, electronics, electro-mechnical, electro-chemical, thermal, material technologies and precision mechanical assemblies.

61. It is not possible to specify any particular research institution because most of the research work is inter-disciplinary in nature. A list of reserach institutions, however, has been identified in a subsequent chapter. Projects should be assigned to institutions from amongst the ones identified, so that integrated R&D takes place.

62. The industry-academia relationship need to be strengthened. More meaningful and result-oriented projects should be offered to the Post-gradute and Research students. Once the feasibilities are demonstrated in the laboratories, the industry should take over the development. The association of researchers from the academic field should be encouraged even in this phase.

63. An extensive information data base containing details of interest to researchers, on indigenously manufactured components needs to be developed, periodically updated and dissiminated among R&D laboratories, research institutes, etc., to assist them in their R&D efforts. DoE has initiated some steps in this direction under STQC programme. Adequate steps, however, have yet to be taken to ensure proper and timely dissemination of information to the users and to ensure prompt availability of desired information throughout the country.

64. Maintenance and repairs services should be recognised as a separate industry. The companies specialising in these areas should be identified and provided with approximate facilities. To inculcate maintenance and service culture, the collaborations should insist upon transfer to know-how, documentation and training in these areas besides specifying the list of spares and equipments/tests required for maintenance. Due attention should be given by the manufacturers to provide maintenance and customer support services at all locations.

65. To bridge the gaps in the availability of technical and scientific manpower in the industry, specific courses should be introduced in the educational curriculum of leading colleges and institutes having a mix of electronics as well as mechanical disciplines. The course should also provide adequate hands-on-exposure in the laboratory and industrial projects. Academic institutions should also be encouraged to provide supporting role of a consultancy nature to the industry and the Government.