

附 属 資 料

1. National IT Plan (英文)
2. 同 上 (和訳)
3. 日本-シンガポールAIセンター設立に関する日本政府への提案 (英文)
4. 同 上 (和訳)
5. Questionnaire (英文)
6. 同 上 (和訳)
7. Questionnaire 回答 (英文)
8. 同 上 (和訳)
9. Proposal for the Establishment of "Japan-Singapore AI Centre
(tentative name)" Project-Type Technical Cooperation Program (英文)
10. 同 上 (和訳)
11. Minutes of Meeting
12. サイト予定地地図

NATIONAL IT PLAN

A Strategic Framework

Prepared By:

National IT Plan Working Committee

Information Technology (IT) embraces the use of computer, telecommunication and office systems technologies for the collection, processing, storing, packaging and dissemination of information.

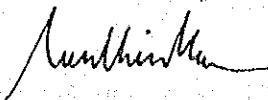
30 Nov 1985

**Chairman & Members,
Committee on National Computerisation**

In late 1984, the National Computer Board together with the Economic Development Board, Telecoms and the Institute of Systems Science discussed the need to map out the role for Information Technology (IT) in Singapore's economic and social development.

In June 1985, a Working Committee was formally set up to produce a National IT Plan. This Plan will present the Committee on National Computerisation a new perspective and strategy for the development and utilization of Information Technology.

The Working Committee has completed the first phase study. We now submit the Interim Report covering the strategic aspects of the National IT Plan.



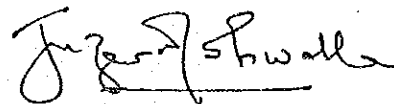
**TAN CHIN NAM
GENERAL MANAGER
NATIONAL COMPUTER BOARD**



**GOH SENG KIM
GENERAL MANAGER
TELECOMS**



**CHUA SOO TIAN
DIVISIONAL DIRECTOR (INDUSTRY)
ECONOMIC DEVELOPMENT BOARD**



**DR JUZAR MOTIWALLA
DIRECTOR
INSTITUTE OF SYSTEMS SCIENCE
NATIONAL UNIVERSITY OF SINGAPORE**



**SUNG SIO MA
ASSISTANT GENERAL MANAGER
(CORPORATE PLANNING)
TELECOMS**

ACKNOWLEDGEMENT

1. The following were co-opted into the Working Committee and they had contributed significantly to the Interim Report:

Dr Wang Kai Yuen
Institute of Systems Science
National University of Singapore

Lim Swee Say
National Computer Board

Yeo Khee Leng
National Computer Board

Loh Chee Meng
National Computer Board

Dr Chia Choon Wei
Telecoms

Ooi Kim Biok
Telecoms

Goh Boon Wah
Telecoms

2. We also wish to acknowledge the contributions of the following:

Edmund Tham
National Computer Board

Miss Thong Pao Yi
National Computer Board

Miss Koh Pia Chin
National Computer Board

Mrs Chin-Tan Tahn Joo
National Computer Board

Dr Francis Yeoh
National Computer Board

Liow Voon Kheong
Economic Development Board

Tan Chin Tuan
Telecoms

Leong Yew Kay
Telecoms

Miss Eng Ngian Huang
Systems and Computer Organisation
Ministry of Defence
(For graphics and production of the report)

TABLE OF CONTENTS

CHAPTER		PAGE
	EXECUTIVE SUMMARY	i - iii
I	INTRODUCTION	1 - 3
II	SIGNIFICANCE OF INFORMATION TECHNOLOGY	4 - 8
III	STATUS OF IT IN SINGAPORE	9 - 17
IV	KEY INFORMATION TECHNOLOGIES FOR SINGAPORE	18 - 24
V	VISION OF SINGAPORE INFORMATION SOCIETY	25 - 30
VI	IT: A NEW BLOODLINE FOR SINGAPORE ECONOMY	31 - 44
VII	AN INTEGRATED STRATEGY FOR SINGAPORE	45 - 53
VIII	RECOMMENDATIONS	54 - 56
IX	FOLLOW-UP ACTION	57

TABLE	ILLUSTRATIONS	PAGE
2.1	WORLD MARKET SIZE OF IT INDUSTRY (1984 AND 1990)	6
3.1	GROWTH OF INTERNATIONAL LEASED CIRCUIT TELEPAC AND TELEFAX SERVICES	13
3.2	SINGAPORE'S COMPUTER MANUFACTURING INDUSTRY - 1983 AND 1984 DOMESTIC EXPORT	15
3.3	VALUE OF COMPUTER SOFTWARE AND SERVICES (1980 - 1984)	17
4.1	KEY INFORMATION TECHNOLOGIES FOR SINGAPORE	19
4.2	RISK & OPPORTUNITY POTENTIALS FOR SINGAPORE	23
6.1	STRATEGIC GRID (Positioning of Industries in relation to their dependency on IT and the impact of IT)	35
6.2	EXAMPLE OF IT APPLICATIONS IN MANUFACTURING SECTOR	37
6.3	EXAMPLE OF IT APPLICATIONS IN SERVICE SECTOR	38

The National IT Plan was submitted to the Economic Committee in November 1985 and since then the Economic Committee had incorporated a Chapter on Information Technology in its Report. With permission from the Ministry of Trade and Industry, we reproduce Chapter 17 of the Economic Committee Report as an inclusion in this special edition of the National IT Plan.

17. INFORMATION TECHNOLOGY

KEY RECOMMENDATIONS

Importance of IT

- 1 Companies in both manufacturing and services must fully exploit the advances in IT to gain a competitive edge.
- 2 It is not enough just to computerise. To be able to compete better, our industries need strategic and creative exploitation of IT.
- 3 Singapore should exploit the opportunities of IT as a new growth industry.
- 4 A consolidated national IT strategy should be implemented, to be spearheaded by NCB, subsuming the present national computerisation effort.

Proposed IT Strategy

- 5 The following IT strategy is proposed:
 - (1) *IT Manpower.*
We must develop a group of IT professionals and experts to enable our enterprises to exploit IT fully.
 - (2) *IT Culture*
Efforts must be made to overcome resistance to change. IT should be taught more extensively in schools.
 - (3) *Information Communication Infrastructure.*
We must continue to improve our telecommunications facilities.
 - (4) *IT Application.*
Many new users, especially the small enterprises, must be provided assistance to overcome their resistance to technology.
 - (5) *IT Industry.*
Every encouragement must be given to promote the development of an IT industry in Singapore.
 - (6) *Creativity and Entrepreneurship.*
We must also develop a local capability in applied research in IT.
 - (7) *Coordination and Collaboration.*
We must coordinate the individual efforts of various organisations involved in promoting various aspects of IT. The NCB should play the leading role.

IT: A Key Technology

1 Information technology (IT) covers the use of computer technology, telecommunications and office systems in all aspects of information flows — from collection and processing, to storage, packaging and dissemination. It has been estimated that by 1990, IT will have direct impact on the production of 30% of world GDP. Present trends indicate that IT will become a key technology in improving business efficiency and labour productivity, and generating new businesses.

2 Advances in IT are already being exploited by business organisations in many countries. The fast-expanding services industry, e.g. health care services, legal services and engineering services, are poised to make vast improvements in service levels through the exploitation of expert systems, large databases, computer-aided design and other IT-related technologies. Large corporations, which used to base their production in countries with low labour costs, have found that with IT-based automation, labour costs can become an insignificant component of total production costs. They can therefore manufacture at home at a low unit cost, despite high local labour costs. IT has also spawned many new businesses utilising micro-electronics, electronic publishing, videotex, satellite TV, etc.

3 The total revenue of the IT industry worldwide in 1984 was estimated to be US\$530 bn. It is projected to grow by more than 10% p.a., to exceed US\$1,000 bn by the early 1990s. This will make it one of the largest industries of the next decade.

4 The advances in IT cannot be ignored by companies. Those that lag behind in exploiting IT will be unable to compete. Their productivity will not improve as fast as their IT-oriented competitors, and their competitiveness will decline from lack of innovation.

Importance of IT to Singapore

5 For Singapore, as international competitiveness is a matter of survival, our companies must be efficient, productive and innovative. Companies in both manufacturing and services need to exploit fully the advances in IT.

6 The service sector is primarily knowledge-based. At present, the average investment per service worker in Singapore is small. Use of IT will result in improved service levels and higher productivity.

7 In the manufacturing sector, we are no longer competing with countries with low labour cost. We will increasingly be competing with advanced countries that are using IT and other advanced technologies to be low unit-cost manufacturers, despite their high wage levels. Singapore manufacturers must similarly exploit IT to reduce the labour content of their manufactured goods to remain competitive.

8 It is not enough just to computerise. What is needed is strategic and creative exploitation of IT by our industries. Our companies must use IT to position themselves in the right market niches, and exploit IT applications in more far-reaching ways than our competitors. Only then can our companies compete better through improved products and better efficiency and productivity.

IT as a New Growth Industry

9 While the major impact of IT will be to raise efficiency and productivity, IT should itself be a growth industry. New IT products, such as optical disc drives and customised chips, are constantly being developed. These are high value-added products which Singapore can manufacture, especially early in the product life cycle, when prices are high, and volumes are relatively low. Manufacturers will look for production bases which offer quick start-ups, a workforce that can be trained up quickly, and good infrastructure for the use of sophisticated technologies. Singapore has these strengths.

10 Advances in IT have also generated a tremendous demand for application and systems software and associated services, e.g. consultancy, turnkey systems, and training. In addition, developments in communications are bringing about new telecommunications services such as value-added networks. Singapore should exploit these opportunities.

Impact of IT on Society

11 Over the next decade, IT will also have an increasing impact on the way we live. Work patterns will gradually change, with growing acceptance of teleworking, i.e. working from homes using computers linked to the office, videotex systems offering opportunities for home transactions in banking, shopping and other remote-based applications. In the home, the most immediate significance of IT will be in education. This is particularly relevant to Singapore, as we should encourage use of home-based instruction packages to learn new skills.

The Need for a National Strategy

12 Over the past few years, the national computerisation effort, spearheaded by the National Computer Board (NCB)

and overseen by the Committee on National Computerisation (CNC), has created the necessary infrastructure and conditions for us to take advantage of computer technology. We have made considerable progress. Many organisations have responded positively to computerisation. This enthusiasm, however, needs to be properly focused so that maximum results can be achieved. As IT is critical to our future economic well-being, it should not be left to fragmented approaches by different agencies. It is important that a new consolidated IT strategy be introduced, to be spearheaded by NCB, encompassing the full spectrum of potential activities. The present national computerisation effort should be converted into a national IT strategy. Such an integrated IT strategy will help organisations in Singapore to exploit IT fully.

PROPOSED IT STRATEGY

13 The following IT strategy, drawn up by a Working Committee with representatives from NCB, EDB, Telecoms and NUS, is proposed:

IT Manpower

The quality of manpower will be the key determinant of our overall IT capability. We must develop a group of IT professionals and experts to enable our enterprises to exploit IT fully.

IT Culture

We must prepare our citizens for the emerging information society. Efforts must be made to overcome resistance to change. IT should be taught more extensively in schools.

Information Communication Infrastructure

Our infrastructure will be the backbone of our information-based businesses. We must continue to

improve our telecommunications facilities.

IT Application

To achieve growth, all economic sectors must try to exploit IT to the full. For the many new users, especially the small enterprises, assistance must be provided to overcome their resistance to technology.

IT Industry

A strong IT industry will be a key driving force for our economy. Every encouragement must be given to promote the development of an IT industry in Singapore.

Climate for Creativity and Entrepreneurship

A stimulating environment which promotes creativity and enterprise is a prerequisite to transform ourselves into an information economy. We must also develop local capability in applied research in IT.

Coordination and Collaboration

To realise the full potential of IT, we need to coordinate the individual efforts of various organisations involved in promoting various aspects of IT. The NCB should play the leading role in this.

EXECUTIVE SUMMARY

1. Jointly developed by the National Computer Board, the Economic Development Board, Telecoms and the Institute of Systems Science, the National IT Plan is to provide the Committee on National Computerisation with a new focus on national computerisation. The Interim Report, a first phase study, provides a strategic framework for the development of the plan. It examines the rapid advances in information technology and their potential impact on Singapore's social and economic development.

2. The impact of IT will be all pervasive with significant social and cultural changes taking place in Singapore's society.

(1) Work patterns will change:

(a) IT applications in the office environment allow innovative reorganisation of work and information flow. One of the likely impacts will be teleworking which frees the employees from the confines of the office but nevertheless enables them to communicate remotely with the office proper.

(b) In factories, robots will be used increasingly and the trend will be towards fully automated factories. With less labour required in automation, it will be easier for the factories to implement a third - shift system.

(c) Working life in the service industry such as retail outlets, hotels, tourism and restaurants will also be affected by IT.

(2) In personal services such as health care, legal advice education, expert systems may see the use of intelligent computers to act as complements to professional expertise.

(3) In the home of the future, IT applications can bring about many changes. The videotex system offers opportunities for home transactions with respect to activities such as banking, shopping, education for self-improvement and leisure pursuits.

3. Currently, Singapore has the components of an IT infrastructure and industry but in the absence of a national IT plan, they are not well integrated. IT is too critical to our future economic and social well-being for its development to be left to a fragmented arrangement with different agencies tackling separate segments. It is therefore important that a new consolidated IT strategy be introduced so as to achieve the full spectrum of IT potential.

4. We must transform our national computerisation effort into a New National IT Drive based on a co-ordinated approach drawing upon the

strengths of various organisations to enable us to achieve our IT vision of the future. Such an integrated IT strategy will provide all organisations in Singapore with a clear view of the future so that their efforts and energies can be channelled accordingly to exploit IT fully in our next phase of economic and social development as well as to enable us to make a good living out of it.

5. We have examined some of the key information technologies and analysed their relevance to Singapore with the objective of deriving social and economic value from these technologies:

- (a) In the core technologies, the basic building blocks of IT, our analysis included microelectronics, mass storage, optical fibre and input-output devices.
- (b) In the application enabling technologies for facilitating the use of the core technologies in functional applications, we have examined CAD/CAM, cellular mobile radios, Value-Added-Networks, Local-Area-Networks, Artificial Intelligence, Operating Systems and Software Productivity Tools.
- (c) Several of these technologies can be effectively exploited in Singapore to create new products and services.

6. NATIONAL IT STRATEGY

The current national computerisation effort is inadequate for fueling future economic growth of Singapore. The National IT Strategy calls for the nation to have the capability for the creative and strategic exploitation of IT:

- (1) as a productivity tool for increasing productivity in all economic sectors, which will enhance business competitiveness;
- and
- (2) as a sectoral industry for making a good living from it by creating new IT related products and services.

7. SEVEN-PRONGED APPROACH

We propose that an integrated seven-pronged approach be taken. Each of the seven prongs is a strategic building block to serve as catalyst for our national IT movement as well as for the development of IT capability in Singapore to achieve our objective of exploiting IT for economic and social gain. The seven prongs are as follows:

IT Manpower

IT professionals are our key asset and main determinant of our overall IT capability. They must be developed into highly skilled champions who are experts in exploiting

	IT to enable our enterprises to gain competitive edge and to introduce new IT related products and services.
IT Culture	We must promote a supportive culture to prepare our citizens for their role in the emerging information economy.
Information Communication Infrastructure	This is the backbone of our information-based businesses and it opens up new opportunities for entrepreneurs. We must aim to continue to have the best telecommunications facilities in the world to maintain a differential advantage in the Information Age.
IT Application	To revitalise our economy, all economic sectors must further exploit IT. For the many new users who are not yet initiated into IT applications, new forms of handholding assistance must be provided to overcome their technological phobia.
IT Industry	A strong IT industry will be the main driving force to push the economy towards a higher level of performance. Maximum encouragement must thus be given to promote the development of a powerful IT industry.
Climate for Creativity and Entrepreneurship	A stimulating environment which promotes creativity and enterprise is a prerequisite to enable us to transform ourselves into an information economy. We must develop indigenous capability in applied research in IT so that we can benefit from advanced technological applications.
Co-ordination and Collaboration	To realise the full potential of IT, we need to unite the individual efforts of various organisations under the leadership of a new National Committee on IT which will evolve from the present Committee on National Computerisation.

8. We have also arrived at a list of recommendations for each strategic building block. These are contained in the report. The above recommended strategy and its seven-pronged approach are not final. In the second phase study, a reconstituted Working Committee will have to look into greater details of this recommendation and also to explore in the other topics uncovered by the present Working Committee.

CHAPTER I

The coming of age of IT calls for a new strategy to exploit IT as an economic resource and as a new area of business

INTRODUCTION

1.1 BACKGROUND

1.1.1 As part of the economic restructuring process of Singapore under a 10 year economic plan introduced in 1980, a high level Committee on National Computerisation (CNC) was appointed in the same year to draw up plans for a national computerisation effort. The main thrust of this national effort was to push the economy into becoming more knowledge and skill intensive, high value-added and technology based through computerisation so that our products and services can be more competitive in the export market. The national computerisation effort was also directed at developing Singapore into a regional centre for computer software and services.

1.1.2 The initial emphasis of the national computerisation effort was in the area of infrastructure building particularly in manpower development. Significant progress has been made in promoting the use of computers in the public and private sectors. The past five years also saw a dramatic increase in activity in the computer services sector with many local and foreign computer companies setting up in Singapore to distribute hardware, software and provide other services.

1.1.3 As we pass the halfway point of the 1980s, it is timely for us to examine the future scenario, in the light of the rapid advancement in information technology. The future scenario is one in which the creative and strategic exploitation of information technology by our industries will finally dictate the successful economic performance of our country.

1.1.4 In Singapore, we need to rethink our way of doing business and of developing the economy. In order to be better than, or at least on par with, our potential competitors who are already fully committed in the development of information technology industry, it is necessary for Singapore to develop a new IT oriented economic strategy. It is imperative to exploit IT as a tool for quantum improvements in productivity, as a strategic tool in improving our business competitiveness, and also as an industry which will enable us to make a good living from it. IT is indeed ideal for the Singapore economy particularly the services sector because it has the highest labour content and it is also the largest sector, contributing more than half of the nation's Gross Domestic Product.

1.1.5 In June 1985, the NCB initiated a Working Committee, comprising representatives from NCB, EDB, Telecoms and ISS, to carry out a study to examine and make recommendations for appropriate new policies and strategies on IT to support the economic and social development of Singapore in the next 10 years.

1.1.6 In August 1985, the Committee on National Computerisation endorsed the formation of the Committee and suggested that the study should be elevated to that of a National IT Plan. The CNC directed that the results of the study should also be submitted to the Economic Committee in October 1985. Thereafter the Working Committee should develop the study further by incorporating the views of the computer industry as well as inputs from the various sub-committees of the Economic Committee which, by that time, should have completed their own studies.

1.2 MEMBERS OF THE NATIONAL IT PLAN WORKING COMMITTEE

Core Members :

- | | |
|--------------------|---|
| Tan Chin Nam | – GM NCB & Board Member, Telecoms |
| Goh Seng Kim | – GM Telecoms & Board Member, NCB |
| Chua Soo Tian | – Div Dir (Industry), EDB & Board Member, NCB |
| Dr Juzar Motiwalla | – Director, ISS & Board Member, NCB |
| Sung Sio Ma | – AGM (Corporate Planning), Telecoms |

Co-opted Members :

- | | |
|-------------------|--|
| Dr Wang Kai Yuen | – Assistant Director, ISS |
| Lim Swee Say | – Div Dir (Info Tech), NCB |
| Yeo Khee Leng | – Director (Industry Development) NCB and Secretary, CNC |
| Loh Chee Meng | – Asst Dir (Industry Development) NCB and Secretary of the Working Committee |
| Dr Chia Choon Wei | – Division Manager (Business Planning) Telecoms |
| Ooi Kim Biok | – Dept Mgr (Business Plan and Service Development) Telecoms |
| Goh Boon Wah | – Engineer (Business Plan and Service Development) Telecoms |

The NCB performed the role of integrator and provided the Secretariat in the Working Committee.

1.3 SCOPE OF STUDY

1.3.1 The objective of the National IT Plan study is to examine and recommend to the Committee on National Computerisation appropriate policies and strategies on IT to support the economic and social development of Singapore through the 1990s.

1.3.2 The Working Committee met in a series of 14 brainstorming sessions addressing issues pertinent to the pervasive influence of IT on the development of Singapore. The efforts of the Working Committee did not duplicate the studies carried out by the Computer Services Industry Working Group and the Working Group on Communications, both under the Services Sub-Committee of the Economic Committee. The IT Working Committee adopted an integrated perspective of IT. The study examined the interplay of *new technologies of which computer services and telecommunication are but two of the constituent components*. A systematic view of the macro issues of IT in social and economic development of Singapore was developed.

1.4 INTERIM REPORT

1.4.1 The first phase of the study has been completed and an Interim Report is hereby submitted to the Committee on National Computerisation.

1.4.2 The aim of this interim report is to present the findings of the Working Committee so far. It is presented as a working document to serve as a basis for further deliberation by subsequent study teams to be commissioned to develop detailed action plans in specific areas.

CHAPTER II SIGNIFICANCE OF INFORMATION TECHNOLOGY

IT is pervasive and a core determinant for new vitality in economic and social development

2.1 DEFINITION

2.1.1 IT embraces the use of computer, telecommunication and office systems technologies for the collection, processing, storing, packaging and dissemination of information.

2.1.2 IT stimulates innovation, opens up markets for new products and services and is the wave of the future in economic management for competitive edge and the restructuring of business practices unconstrained by geographical span. The pervasiveness of IT will change the economic and social fabric of society leading to a better quality of life for Singapore.

2.1.3 There are numerous products and services associated with IT in the marketplace. They can be categorised into five major segments:

a. Transmission Services

Facilities offered for transmitting information. Some examples are telebox, telephone, paging service, videotex.

b. Information Services

Information and facilities offered for processing information. These include data bank, computer service bureau, electronic directories.

c. Computer and Telecommunication hardware

Hardware components used for storing, processing and disseminating information. For example, microelectronics, fibre optics, data storage device, Local Area Network.

d. Information Processors

Hardware and software integrated products used for managing information. For example, computer, PABX, office systems.

e. Information Products

Information delivered as a product such as electronic publishing of books, magazines and newspapers.

2. THE IT INDUSTRY

2.2.1 IT is an international industry as information is a global commodity. It is recognised by many countries as a substantial contributor to national economic performance. The worldwide market is currently dominated by the USA, Japan and the European Community. Many other nations including Australia, China, Taiwan, Republic of Korea and Brazil are actively pursuing niches in this huge and expanding market.

2.2.2 Competition in the IT industry is very keen. To keep ahead of competitors, IT companies spend about 10% of their revenues on R&D and product development annually. Companies which are not able to compete singly are joining forces to undertake R&D in areas essential for their survival and growth. Government agencies are also very much involved in funding and charting R&D programmes to encourage collaborative R&D between industry, academic institutions and public sector organisations. These R&D programmes are typically goal-directed with well defined focus for each of the research activities.

2.2.3 Governments, besides funding and coordinating R&D programmes, have also commissioned studies to develop integrated plans at the national level to strategise the building up of export oriented IT industries.

2.2.4 The heavy investment in R&D will continue to result in impressive improvements in cost performance of IT and shortening of product life cycles. It will open up tremendous opportunities for business innovations and market exploitation. The countries and organisations that are able to digest the rapid advancements in technology and respond quickly to market opportunities will be able to reap maximum benefits from IT.

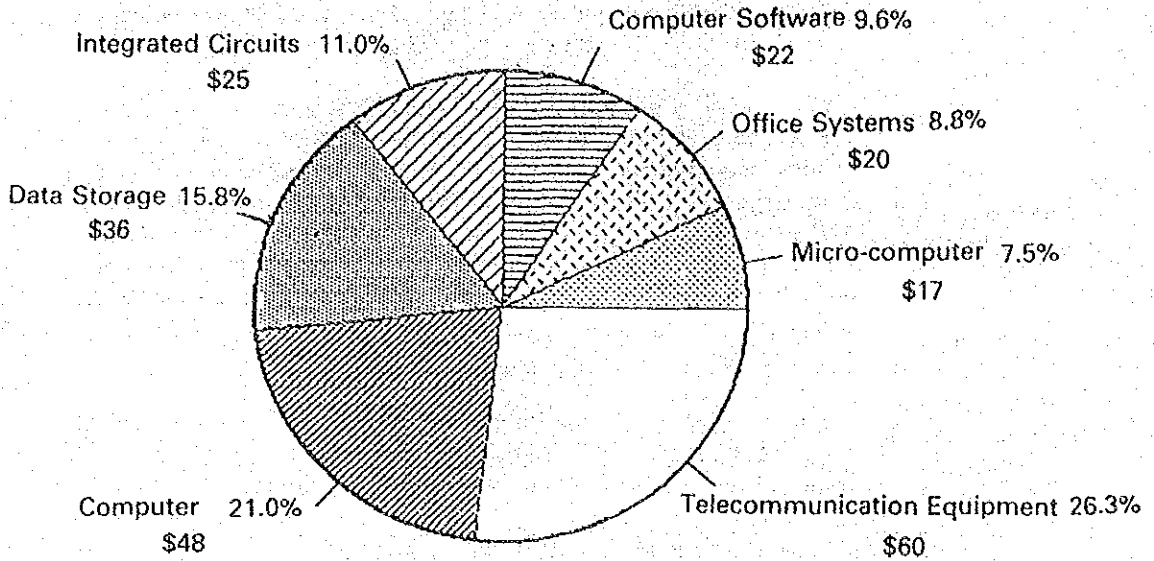
2.2.5 Since the early '70s, the IT industry has witnessed accelerated technological developments and innovations. The miniaturization of electronic components and the rapid improvement in price-performance ratios have led to significant advancements in the handling of information and rapid expansion of the IT industry. According to a study conducted by SRI International, the total revenue of IT industry worldwide in 1984 was estimated at US\$530 billion. It is projected to grow at more than 10% annually to exceed US\$1 trillion by early 1990's. It will become one of the largest industries of the next decade.

2.2.6 Table 2.1 shows the dollar market value of the major IT segments in international markets. The growth rates from 1984 to 1990 are impressive, especially for computer software which is projected to rise an annual average of 33%.

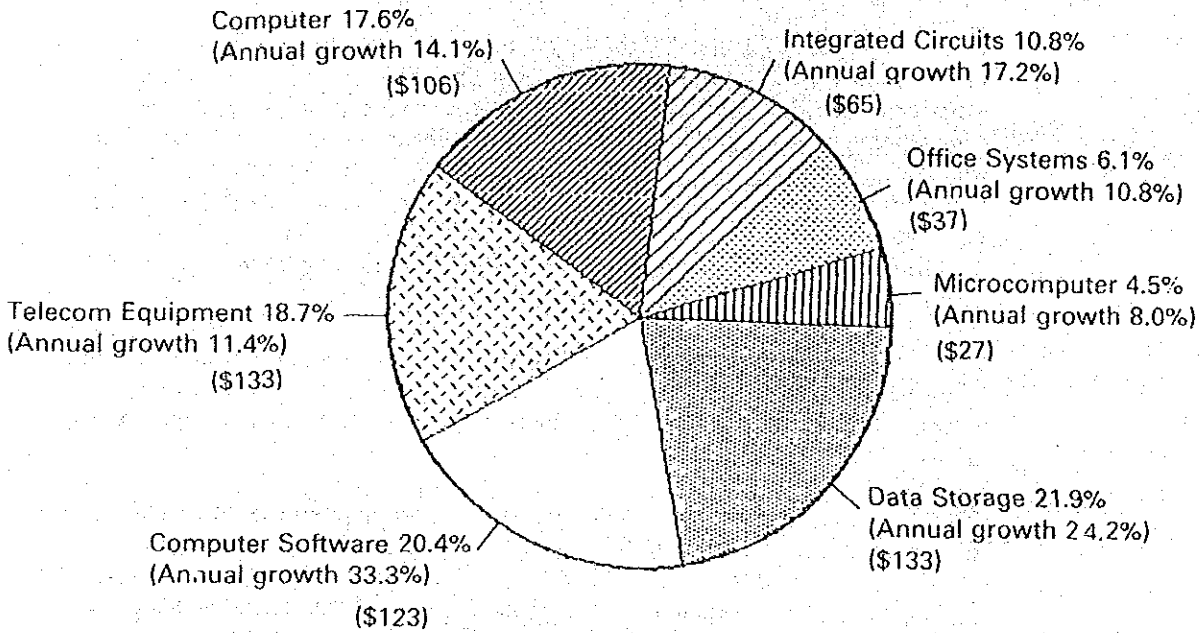
2.2.7 The huge size of the IT market and its growth potential have made governments and international organisations increasingly aware of the extent to which economic health will be influenced by the ability to respond swiftly to market needs in order to capture a share of this market. Singapore has the opportunity to address the strong demand for IT products and services. However, Singapore must move quickly.

TABLE 2.1

**WORLD MARKET SIZE OF IT INDUSTRY
(Major IT Segments in Currents '84 Market Value (US\$'billion))**



**WORLD MARKET SIZE OF IT INDUSTRY
Estimated 1990 Market Value (US\$ 'billion)**



Source : SRI International

2.3 **IMPACT OF IT ON PRODUCTIVITY, EMPLOYMENT AND COMPETITIVE EDGE**

2.3.1 IT is the key technology to improve labour productivity, preserve employment and stimulate business growth in the 1980's and beyond. The application of the technology will reduce employment through higher productivity on one hand and will create employment on the other hand by stimulating business growth in other business sectors and the IT industry itself.

2.3.2 Advances in Information Technology are exploited by some countries and business organisations to gain a competitive edge over others. IT has been used to raise the standard of living, release workers from routine and monotonous jobs, improve productivity, lower costs of doing business, enhance customer satisfaction, and create new business opportunities through the creative and innovative use of the technology. In the long run, higher employment will be achieved as the growth of business through improved productivity and competitiveness will offset any displacement from automating factories and services.

2.3.3 The employment share of the IT industry in some countries will increase. In USA, the IT industry is a dynamic source of employment growth. The Department of Labor forecasts that employment in that sector will grow by 38% between 1982 and 1995, compared with the total rise in employment of 28% for the whole economy. The USA and Japan are good examples of countries which have experienced strong employment growth through rapid application and innovation of IT. They have also illustrated the opportunities presented by the technology for entrepreneurs and workers to enjoy profit and higher income.

2.3.4 Countries and organisations which lag behind in exploiting IT will lose out heavily. Their productivity will not improve as fast as that of their competitors, and their competitiveness will decline from lack of innovation. Eventually, employment will be lost to imports from innovating countries.

2.4 **IMPACT OF IT ON GLOBALISATION OF BUSINESSES**

2.4.1 IT has created a major shift in international comparative advantage. It has globalised business operations and allowed countries and organisations with advanced IT facilities to be integrated into the international business community, and overcome any constraint imposed in the past due to their distance from the economic powers. On the other hand, it also implies that countries and organisations which fall behind in the use of IT will not compete favourably in this globalised business environment.

2.4.2 Advances in IT have allowed international organisations to integrate their businesses across national boundaries and altered significantly the patterns of international division of labor. In production, industrial operations are being internationalised to give rise to the concept of a global factory. Manufacturing process is being reorganised and segmented into design, fabrication, assembly and testing. In an industry such as the IT industry where the rate of technological change and product obsolescence is rapid, these production processes are performed across national boundaries

to capitalise on the favourable factors of production offered by the developed and developing countries. These factors include the availability of materials, the cost of workers, the quality of skilled labor, and the responsiveness and flexibility in reorganising production facilities to meet changing production specifications.

2.4.3 In services, businesses are likewise increasingly being integrated across national boundaries. The costs of communications and transportation have declined, while that of personnel has remained relatively high. Business information and expert resources will have to be used optimally to reduce cost of business and to have an edge over the business competitors. The diffusion and integrated use of computer and communications technologies will support and speed up the establishment of international information networks which are fast becoming integral components of major business operations.

CHAPTER III STATUS OF IT IN SINGAPORE

Singapore has the components of IT infrastructure and industry but they are not integrated in the absence of a national IT policy

3.1 GOVERNMENT POLICY

3.1.1 The National Computer Board (NCB) was set up in 1981 to implement the national computerisation plan recommended by the Committee on National Computerisation, namely:

- (1) the development of Singapore's capability in using computers; and
- (2) the development of a viable computer services industry.

3.1.2 The National Computer Board was tasked with the responsibility of:

- (1) co-ordinating computer education and training;
- (2) implementing a massive computerisation programme for the entire Civil Service; and
- (3) promoting the computer services industry.

3.1.3 The composition of the Board of Directors of the NCB included major organisations, among them the EDB, Telecoms and NUS, which would play key roles in helping the country to meet its overall objectives of promoting the usage of computers to upgrade the economy and to develop Singapore into a centre for computer software and services.

3.1.4 Over the past 5 years Singapore had a national computerisation policy but not an integrated IT policy. CNC did not make specific recommendations about telecommunications and the manufacturing of computers, two major IT activities under the purview of Telecoms and EDB respectively. It was only in 1983 that Telecoms and NCB had mutual cross representation on their respective Boards of Directors, a step in the right direction because computer and communication technologies were rapidly merging.

3.1.5 The division of responsibilities between EDB and NCB for promoting the manufacturing of IT products and the development of the computer services respectively is a fine line. Very close coordination is necessary because for many large computer manufacturers, hardware and software manufacturing investments are not mutually exclusive activities and therefore the promotion of both could be carried out in parallel. Also, NCB as directed by CNC is dependent on incentives administered by EDB for promoting the computer services industry. This makes cooperation between the two organisations even more important.

3.2 SITUATIONAL ANALYSIS

3.2.1 Manpower Development

3.2.1.1 In 1980 there were an estimated 850 computer professionals in Singapore and the target was to produce 6000 to 8000 new computer professionals by 1990. Today, there are 4000 computer professionals, a five fold increase since 1980. The increase in computer professionals was due to :

- a) A larger intake of students by the Department of Information Systems and Computer Science (DISCS) in the National University of Singapore (NUS). From a student enrolment of 70 in 1980, DISCS expanded its enrolment to 200 today.
- b) The establishment of three computer training institutes :
 - i) the Institute of Systems Science (ISS) in 1981, a partnership between IBM and NUS;
 - ii) the Japan Singapore Institute of Software Technology (JSIST) in 1982, a joint project between the Governments of Singapore and Japan.
 - iii) the Centre for Computer Studies (CCS) in 1982, a partnership between ICL and Ngee Ann Polytechnic.

These three training institutes have doubled their combined student intake from 200 in 1982 to 400 in 1984.

- c) The return of Singapore students who had pursued computer studies overseas. About 200 to 300 Singaporeans each year enrol for computer related studies abroad.
- d) The conversion of working professionals in other disciplines to the computer profession.
- e) The entry of foreign computer professionals in the computer labour market.

3.2.1.2 Most of the local professionals have less than three years of computer working experience. Currently 20% of the computer professionals who have eight or more years of experience are employment pass holders. The demand for high level computer professionals cannot be fully met locally and Singapore will have to continue to accommodate suitable foreign professionals to supplement the computer labour force.

3.2.1.3 Singapore will be able to meet the original target of producing a pool of 8000 computer professionals by 1990. However, rapid technological changes require that the industry has professionals with hardware and communication expertise. It is therefore necessary to address the need for this type of computer professionals in the next phase of our manpower development.

3.2.2 Computer Literacy

3.2.2.1 In the past five years, many organisations have rallied to the Government's call to promote a computer literate society in Singapore. The major programmes are as follows:

(a) Every secondary school in Singapore has a microcomputer appreciation club. In 1984, there were no less than 134 of such clubs catering to a student membership of over 16000. More than 500 microcomputers have been installed in secondary schools. Over 700 teachers had been trained by CDIS.

(b) Every junior college offers Computer Science at 'A' Level. Each college is equipped with a minicomputer system or a local area network of microcomputers. Between 100 to 200 students take the subject in each junior college.

(c) Both the Singapore Polytechnic and the Ngee Ann Polytechnic have introduced compulsory computer courses for all the students and are now introducing CAD/CAM training courses.

(d) At the National University of Singapore, computer courses are offered practically in every faculty either as an optional or compulsory course.

(e) The Nanyang Technological Institute has submitted plans to create a computer intensive environment

3.2.2.2 Outside of the public educational institutions, organisations such as:

(a) The People's Association has set up over 30 microcomputer clubs in Community Centres offering appreciation courses to the general public.

(b) The National Trade Union Congress has been running computer classes at four workers centres since 1982.

(c) The Singapore Armed Forces Reservists' Association is another active contributor towards computer literacy in Singapore running very popular computer classes for its members.

(d) In the private sector, many schools have sprouted up over the years offering computer courses to the public. About 30 such centres are in existence.

3.2.2.3 Notwithstanding the spread of computer literacy, there was no proper co-ordination among the various organisations involved in this area. In fact, while the whole movement had been rather spontaneous, yet the result is very encouraging. In terms of general awareness of computers, Singapore is ahead of most countries, including some developed countries. However, we should be asking ourselves whether more mileage

can be obtained from computer literacy than just learning basic programming which is the feature of most computer awareness programmes. With the availability of many advanced software packages running on the microcomputers, programming skills are not required to derive useful utility out of these packages.

3.2.2.4 An important application of computers is computer assisted instruction (CAI) for the teaching of mathematics and science subjects, using a computer and relevant courseware. We have made very little progress in the area. All our secondary schools have microcomputers - the opportunity to use computers as an educational tool exists. The problem is really to develop adequate courseware. To that effect, some organised effort is needed to promote CAI.

3.2.3 Computer Usage

3.2.3.1 Since 1980 computer installations of mainframe and minicomputer have escalated more than five times from 350 to more than 2000 in 1984. Over the same period more than 40,000 microcomputers were sold locally.

3.2.3.2 Computers are found in all the economic sectors and they are widely used in administrative applications like finance, personnel and inventory. Computer networks are also making their appearance in Singapore and the principal users of large computer networks are the banks, the airline industry and the MNCs. Home banking has already been introduced in Singapore by some banks. Another important network recently installed is the electronic funds transfer from point of sales (EFTPOS) where customers at certain participating retail chains can carry out cashless shopping.

3.2.3.3 We continue to face a problem among the relatively small businesses. Lacking funds and resources, the small companies cannot afford professional expertise for their computerisation needs. They turn to vendors who may not have sufficient technical skills to offer and the result is often a mismatch. We have to address this problem area.

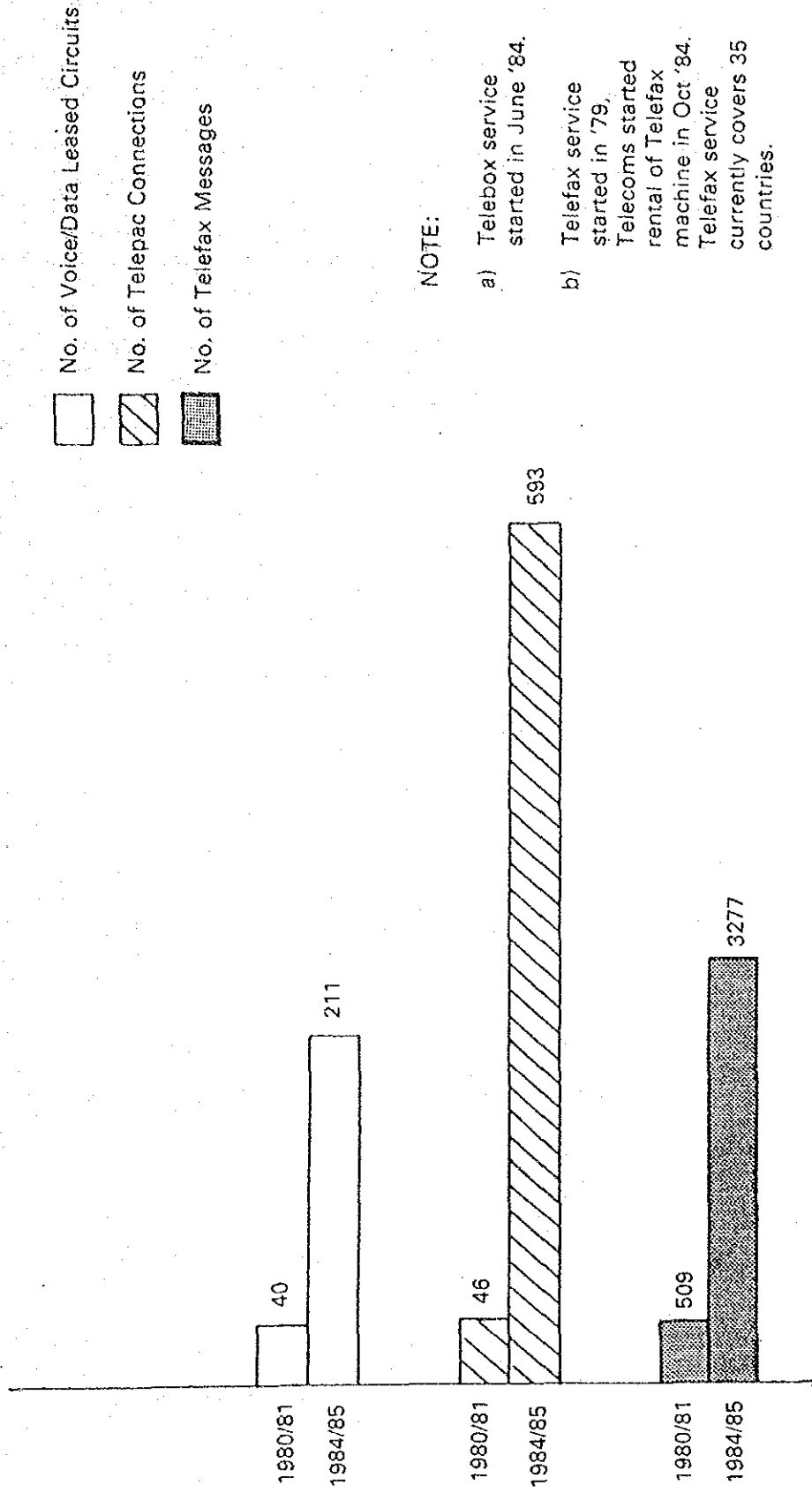
3.2.3.4 The public sector, consisting of the Civil Service and the Statutory Boards is a major user of computers. Since the implementation of the Civil Service Computerisation Programme (CSCP), the public sector has acquired experience in areas such as quality assurance, computer security, project management, software engineering, software development and user education. This experience can now be shared with the industry.

3.2.4 Telecommunication Infrastructure

3.2.4.1 Telecoms is the national authority on telecommunication matters. Over the past five years, it has been very progressive in providing advanced telecommunication facilities to support the growing rate of computerisation. It has introduced packet switching facilities for computer users to communicate with each other over the public lines; private leased lines for those with heavy communication traffic; dial-up facilities for those who want to send data over the usual telephone lines; telebox, an electronic mail system; and telefax, a facsimile service for transmitting documents from one place to another. (see Table 3.1).

TABLE 3.1

GROWTH OF INTERNATIONAL LEASED CIRCUIT,
TELEPAC AND TELEFAX SERVICES
(1980 - 1985)



NOTE:

- a) Telebox service started in June '84.
- b) Telefax service started in '79. Telecoms started rental of Telefax machine in Oct '84. Telefax service currently covers 35 countries.

Source : Telecoms

3.2.4.2 Telecoms is also experimenting on the use of optical fibres and is the first in the world with a live trial project connecting three exchanges with optical fibres. To prepare for an Integrated Services Digital Network (ISDN) which will be able to carry data in text form, image form or voice, it has planned to digitise its entire public telephone network.

3.2.4.3 Telecoms has also announced plans to invest \$40 million in R&D to develop a national Teleview system which will bring more information services to homes and offices in the future. Applications like teleshopping, ordering consumer goods through the home computer, booking of airline tickets, accessing data bases on stocks and shares, libraries etc. will be made possible through Teleview.

3.2.4.4 Telecoms has also been aggressively developing Singapore as a node for an international network of undersea submarine cables. With advances in optical fibre technology, this network of submarine cables could be replaced with optical fibres and thus provide Singapore an even more important niche in the global information network. Complementing the submarine cable communication networks is satellite telecommunication. Telecoms is currently working with both the Intelsat and Inmarsat satellites and is also building a new earth station site for five new antennae.

3.2.5 **The Computer Manufacturing Industry**

3.2.5.1 Singapore's computer manufacturing industry is geared to the international market and has little relationship to domestic demand. Hence, an international IT perspective for the industry is more relevant than a domestic one.

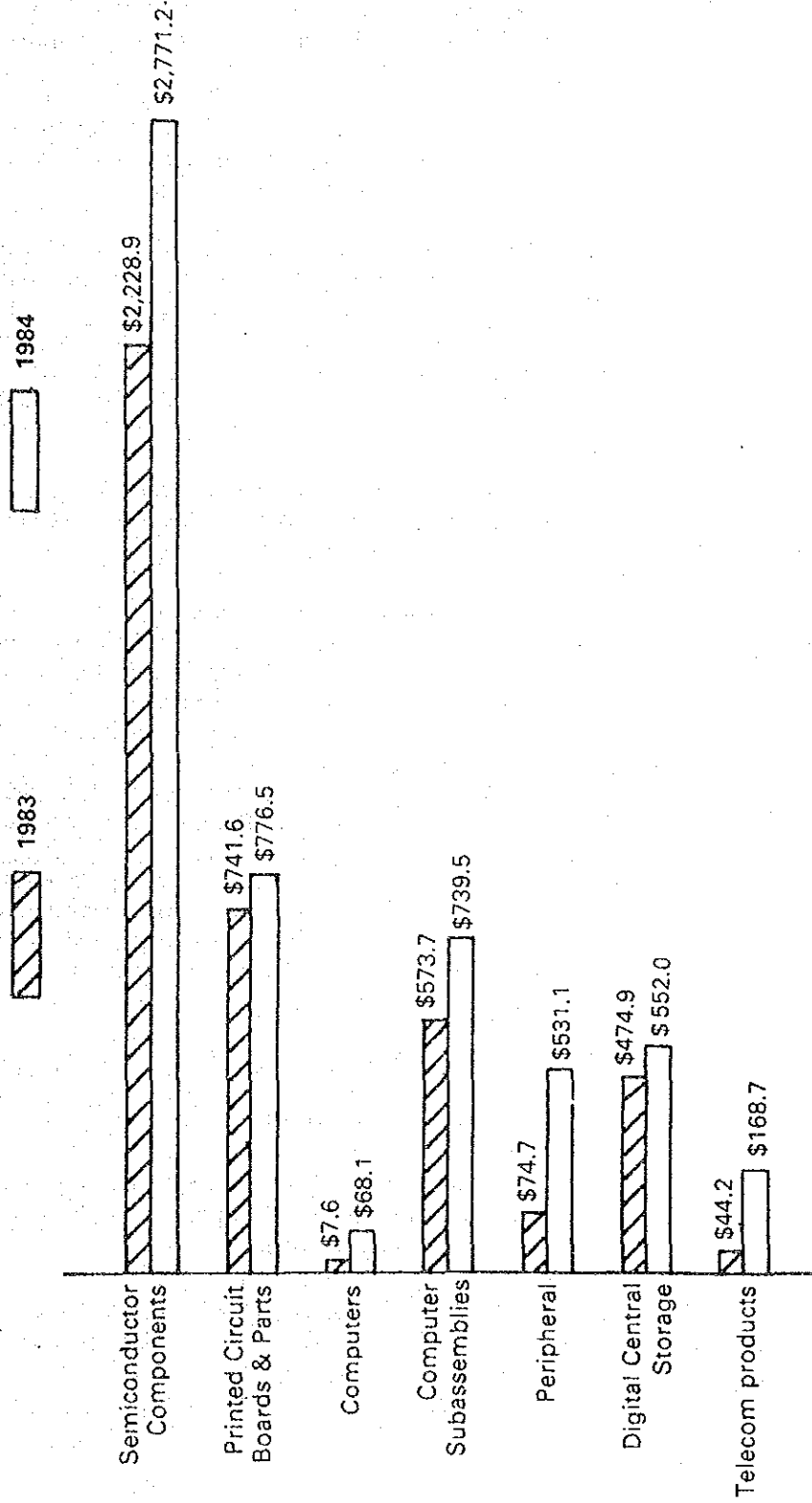
3.2.5.2 The computer manufacturing industry has grown explosively in the last three years. Capital investments flowed in mainly from the US to which most of the manufactured output are also shipped.

3.2.5.3 The main growth products are computer subassemblies, peripherals and digital storage devices which together accounted for \$1.83 billion in 1984 out of a total shipment of \$2.06 billion from the computer manufacturing industry. (see Table 3.2).

3.2.5.4 The EDB continues to regard computer manufacturing as a priority sector in its promotion programme. The future growth of this industry in Singapore will be dependent on Singapore's ability to respond to world demand and its overall competitive position.

TABLE 3.2

SINGAPORE'S COMPUTER MANUFACTURING INDUSTRY
 - 1983 AND 1984 DOMESTIC EXPORT (\$\$ MILLION)



Source : Economic Development Board

These hardware products can be used as inputs for both IT systems and consumer electronics.

3.2.6 The Computer Services Industry

3.2.6.1 Since 1982 an average of seven new computer companies entered the market each month. The number of companies has grown from 55 in 1980 to 370 in 1984. Two thirds of these companies are small, lack technical expertise and serve mainly as retail outlets for microcomputers. The remaining one-third consist of the following :

- a) Multinational vendors like IBM, HP, NEC which market proprietary hardware, software as well as provide support services like training and maintenance.
- b) Independent systems houses serving as value-added distributors and system integrators for foreign hardware and software vendors. They provide suitable configuration of hardware from different computer manufacturers and adapt or modify licensed software packages for specific customer requirements. Few of these system houses have progressed to develop software on their own.
- c) Management Consultancy Division of Audit firms which advise their clients on computerisation. They serve mainly the large and medium sized firms.

3.2.6.2 The computer services industry registered high growth as reflected in the rise of revenue from \$259 million in 1982 to \$474 million in 1984. About 80% of their earnings were in the domestic economy and 20% from export. (see Table 3.3). The large computer companies which are made up of foreign computer vendors and a few local distributors constitute less than 15% of the 370 computer companies in the industry. However, they account for more than 70% of the industry's revenue. This suggests that the large companies are the driving force in the computer services industry.

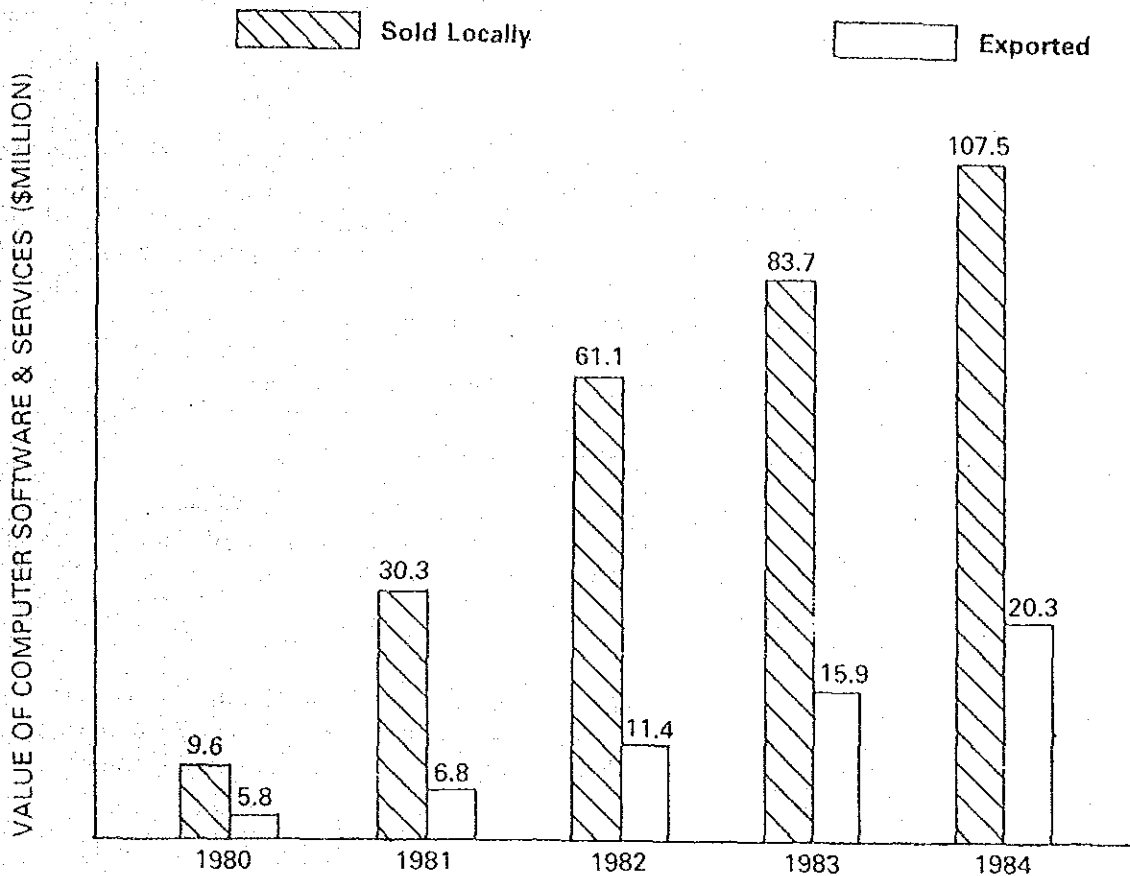
3.2.6.3 Most of the local computer companies are concentrated in the very competitive domestic retailing of microcomputers and related software. Consequently, they emphasize the selling functions and provide a useful service to the public. However, their manpower profile does not make them potential candidates for major software development efforts.

3.2.6.4 Following the guidelines from the CNC in promoting the computer services industry, the Industry Development Department in NCB embarks on very selective promotion emphasizing :

- a) The establishment of software R&D centres by major international computer firms in Singapore to effect technology transfer to Singaporeans.
- b) The promotion of local software companies to upgrade their expertise and be more export-oriented.

TABLE 3.3

VALUE OF COMPUTER SOFTWARE & SERVICES
(1980 - 1984) (S\$ MILLION)



Source: National Computer Board

3.2.6.5 As an integral part of industry promotion the NCB also organises overseas missions, sometimes jointly with the Trade Development Board, to bring our local software firms overseas to explore possibilities of joint-ventures with foreign companies or to look for new market potentials, e.g. the China market.

3.2.6.6 The NCB has also established an overseas office in Boston in July 1985 to spearhead its promotion drive in the US.

3.2.6.7 The NCB is presently using incentives developed by the EDB for the promotion of the manufacturing industries, to promote the computer services industry. As the task of promoting software development progresses, specific new incentives for the computer services industry, such as software development grants and loans will be needed for more effective promotion.

CHAPTER IV KEY INFORMATION TECHNOLOGIES FOR SINGAPORE

The new technologies offer Singapore a basis to make a good living through the exploitation of IT

4.1 OVERVIEW

4.1.1 The IT industry is technology rich. There are numerous technologies currently available in the marketplace, and more will emerge from the research laboratories as they mature to the commercialisation stage. The Working Committee examined some of the key information technologies and analysed their relevance to Singapore with the objective of deriving social and economic value from these technologies.

4.1.2 In the area of core technologies which constitute the basic building blocks of IT, the technologies studied included microelectronics, mass storage, optical fibre and input-output devices.

4.1.3 In the area of application enabling technologies which facilitate the use of the core technologies for functional applications, the technologies studied include CAD/CAM, cellular mobile radios, Value-Added-Networks, Local-Area-Networks, Artificial Intelligence, Operating Systems and Software Productivity Tools.

4.1.4 In identifying the potential areas for exploiting IT, the characteristics, limitations and technological trends of each of the core and enabling technologies were examined. The results of the analysis are summarised in Table 4.1.

4.2 TRENDS IN IT

4.2.1 Information Technology is growing so fast that it is difficult to discern the overall pattern of the technology. However, there is a general agreement within the industry that certain major technological trends do exist and are likely to continue into the 1990's.

4.2.2 In microelectronic technology, the semi-conductor industry will continue to double the number of components per chip each year. The market for memory chips is now crossing from 64K chip to 256K chip, and will move on to the 1 Mega chip by the end of the decade. By then, sub-micron technology will be used in the commercial production of memory chips. The quest for smaller size, greater speed, lower power consumption, reduced heat output, higher reliability and easier design and testing will lead the semi-conductor industry towards new technologies and materials. It is likely that Optoelectronic, using gallium arsenide, will spearhead the development of new silicon techniques and architectures.

**Table 4.1 KEY INFORMATION TECHNOLOGIES
FOR SINGAPORE**

Technology	Product Development	Application	Manufacturing	System Integration	Services
Core Technologies					
○ Microelectronics	*	*	*		
○ Mass Storage	*	*	*	*	*
○ Optical Fibre		*	*		*
○ Input/Output	*	*	*	*	*
– Printers		*	*		
– Optical Character Readers	*	*			
– Display Technology	*	*	*		
– Imaging Devices		*			
– Pointing Devices		*			
– Voice Input/Output		*			
– Card Systems		*			
Application Enabling Technologies					
○ CAD/CAM	*	*		*	*
○ Cellular Mobile Radio		*	*	*	*
○ VAN	*	*	*	*	*
○ Local Area Network		*		*	*
○ Artificial Intelligence	*	*			*
○ Operating System	*	*			*
○ Software Productivity Tools	*	*			*

4.2.3 In workstation technology, the use of the keyboard is likely to continue for many years. It will however be complemented by the increasing use of pointing devices such as touch sensitive screen and the mouse (a user friendly interface). The trend towards high resolution graphics screens and the use of split screens will continue into the 1990's. The display quality of flat screens will improve and it is likely to be used widely by mid 1990's. Future developments in voice recognition and hand writing recognition technologies will be exciting. The use of such technologies will change significantly the way we interact with IT related products.

4.2.4 In printer technology, the trend is toward high quality, high speed, coloured and non-impact printing. Non-impact printing technologies such as ink-jet, xerographic, thermal and electrostatic technologies are leading contenders in the industry.

4.2.5 In storage technology, the cost per megabyte of disk storage will continue to decline. The performance of magnetic storage media will continue to improve through the use of thin-film head, thin-film surface and vertical recording technology. It is expected to continue to dominate the mass storage market till mid 1990's, after which the optical disk storage technology will have replaced it.

4.2.6 In communication technology, the developments in optical fibre, Local Area Network and cellular radio will be exciting. The benefits of using optical fibre are improving and will make it a more attractive medium for the transmission of data. Systems which combine the best features of LAN and PABX will emerge, and the use of cellular radio will be extended to data services as well. Usage of Value-Added-Network services will grow while that of telex will decline. Integrated Services Digital Network will be introduced gradually.

4.2.7 In software technology, the development of software productivity tools and research in software engineering will be among the main areas of emphasis for the rest of this decade. The incorporation of Artificial Intelligence capability in software will lead to the development of a new generation of software which is more capable of solving complex problems and will allow users to communicate using natural languages.

4.3 RELEVANCE

4.3.1 The relevance of IT to Singapore is viewed broadly from the following angles :-

a) Product Development and Innovation

Opportunities for developing innovative IT related products and services to create new business opportunities or enhance the competitiveness of existing businesses.

b) Application

Opportunities for using IT related products and services available in the international marketplace to improve productivity and competitiveness of businesses, and upgrade our quality of life.

c) Manufacturing

Opportunities for creating employment and producing IT related products and components for export.

(d) Systems Integration

Opportunities for providing value-added services and integrating the technologies into total systems, with enhanced value, to the customers.

e) Services

Opportunities for offering the use of facilities and expert resources to clients for marketing, distribution, warehousing and use of IT related products and services.

4.4 OPPORTUNITIES FOR EXPLOITATION

4.4.1 In Microelectronics, Singapore has built up a pool of local talents in assembling and testing ICs. This source of expertise can be further developed to design, develop and manufacture automated IC assembly and test equipment. Collaboration with technology leaders to develop new IC products and manufacturing processes, and the setting up of silicon foundries to fabricate small production runs of custom and semi-custom IC will further upgrade local expertise.

4.4.2 In Mass Storage, Singapore has established a strong base to support high volume production of magnetic storage systems. The industry will be upgraded to produce the next generation of storage systems based on optical technology. Development of key components such as motors and optical read/write mechanisms are within our capability. Effective use of industrial robots coupled with our upgrading of production skills will enhance our position as a world leader in producing mass storage systems.

4.4.3 For Optical Fibre, Singapore will be a key user of this technology in establishing a highly efficient and reliable telecommunications network in the wake of the information age. This will generate tremendous demands for new communication interfacing and multiplexing equipment for linking electronic based IT products to the optical based information carrier. It will also open up the market for ultra high speed office equipment and computer systems. The demand for these products is worldwide, and there are market niches for us to explore. The expertise gained in the use of optical fibre in Singapore can also be a source for export to other developing countries.

4.4.4 In Input-Output Devices, Singapore currently manufactures monitor, keyboard and printer. Other potential areas for manufacturing include large LCD/electroluminescent display panel, plotter, optical and magnetic character recognition systems, voice recognition and synthesis systems. There is tremendous scope for using these I/O devices in office automation and computer integrated manufacturing. Expertise in integrating these sub-systems with computer, telecommunications network and office equipment

will be critical. Such indigenous capability can be developed through applied research and experimentation conducted locally, thereafter exported to other developing countries.

4.4.5 As for CAD/CAM, there is tremendous scope for applying this technology as an integral component of Computer Integrated Manufacturing in the production of high value added items. The use of CAD/CAM will provide us the competitive edge in engineering productivity, and develop Singapore into a regional technology centre in the use of CAD/CAM and CIM. There is room for creative software development as well.

4.4.6 For Cellular Mobile Radio, the technology is in its infancy. There is a need to integrate the technology to ISDN and Singapore is in an excellent position to prototype products and conduct experimentation. Worldwide demand for products such as radio telephones will pick up rapidly when the technology becomes more economical and widely used in both the developing and developed countries. Singapore can be a test bed for product development and innovations, and a production centre for such technology.

4.4.7 In Value-Added-Networks, more services will be offered to make Singapore a regional information and communication centre, and an international showcase. It will improve our quality of life, and equip our business sectors with the competitive edge to operate effectively in international business operations. The large scale implementation of VANs locally will offer the much needed opportunities for local businesses to create new and innovative markets which can later be expanded to overseas market.

4.4.8 In Local Area Network, the technology will be widely used to serve as a highway for transferring information and sharing IT resources in a geographically confined area such as within the office building. It will be used in automating offices and factories, and be interfaced to public networks to provide linkage to the outside world. Expertise in networking for compatible LANs and IT products is in short supply worldwide. It is a market niche for Singapore to develop the expertise in systems integration.

4.4.9 In Artificial Intelligence (AI), the technology is beginning to be used in commercial applications and is one of the major growth sectors in IT. In time to come, AI will become the main stream of software development in that most software will exhibit some forms of human-like reasoning capability. The main factor limiting the growth of AI applications is the worldwide shortage of AI trained manpower. In view of the tremendous scope for application and the great demand for AI-based software in the international marketplace, it is crucial for us to build up a pool of professionals competent in the use of this under-exploited technology.

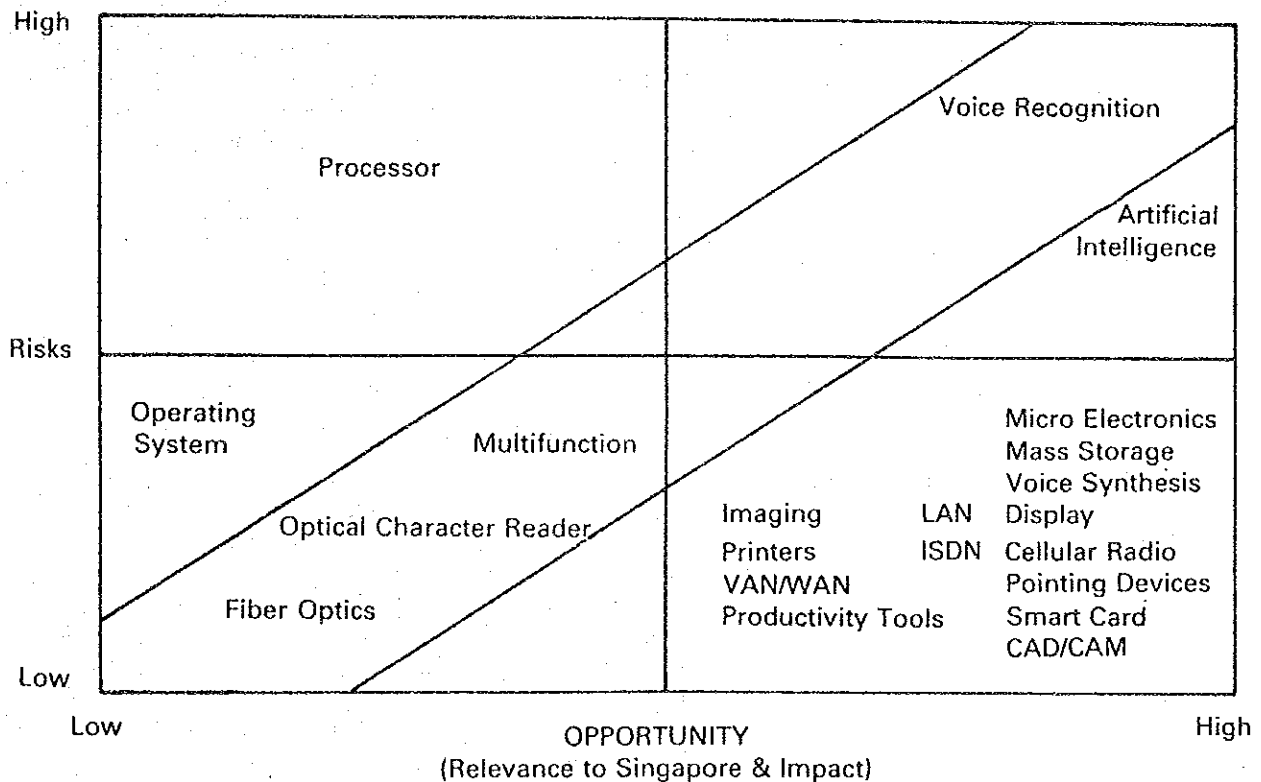
4.4.10 In Operating Systems, the current trend indicates that the minicomputer and microcomputer range of computer systems will be dominated by the UNIX operating system. To facilitate future exports of software and expertise, the industry should develop expertise in developing software under the UNIX operating environment. The mainframe computer systems will continue to be dominated by the use of IBM operating systems.

4.4.11 In Software Productivity, significant progress in software engineering can be expected and the use of program generators and software development tools will become the norm in the software industry. Expertise in software engineering will be key to ensuring that our computer professionals can compete well internationally both in professional productivity and software quality. The market for software engineering tools will be among the fastest growing sectors in the IT industry and is a market niche which Singapore should pursue actively.

4.4.12 Of all the microprocessor-based card systems, the Smart Card has the greatest potential to be used as an allpurpose card for multiple transaction usage like EFTPOS, ATM card, credit card and personal identification card. With research work going on in the developed countries to eventually commercialise the Smart Card, Singapore with its compact and highly urbanised society can be an ideal place to conduct pilot project on the use of the Smart Card as well as to develop application on the Smart Card which are specific to our environment.

4.4.13 Table 4.2 summarises the relationship between the market opportunities and risks for Singapore in exploiting the key technologies. The

TABLE 4.2 : RISK & OPPORTUNITY POTENTIALS FOR SINGAPORE



horizontal axis indicates the opportunity open to Singapore. The more a technology is placed to the right, the greater is the potential this technology holds for Singapore. The vertical axis indicates the technological risk for the technology in question. The more mature the technology, the lower is its risk and so it is placed at the lower end of the scale. Two diagonal lines are drawn to separate the technologies into three categories:

- a) The technologies within the diagonal lines are marginally exploitable.
- b) The technologies outside the diagonal lines and to the right are highly exploitable.
- c) The technologies outside the diagonal lines and to the left are nonexploitable.

4.5 IMPLICATIONS

4.5.1 The social and economic values of IT can be derived in several ways. Among them are the development of innovative products to compete in the international marketplace, the use of IT to improve quality of life and improve productivity, the manufacturing of IT products to create employment, the integration of IT products to exploit IT creatively to give us the competitive edge, and the offering of expert services in the use of IT to other developing countries.

4.5.2 The opportunities identified for each technology are based on our preliminary analysis by looking at the characteristics of the technology and the current level of local expertise. Further studies will be required to analyse the comparative strength of our industry with that of the other potential competitors.

CHAPTER V VISION OF SINGAPORE INFORMATION SOCIETY

The impact of IT will be all pervasive with profound social and cultural changes taking place in Singapore's society

5.1 INFORMATION SOCIETY

5.1.1 At our brainstorming sessions, we discussed the structural changes that will possibly accompany the transition into the information society. The issues confronting the information society, albeit generalised, are nevertheless applicable to Singapore in moving into the information age.

5.1.2 The convergence of electronics, computing and telecommunication together with the unleashing of a tidal wave of technological innovation is not solely confined to the world of science and technology, it will bring about dramatic changes in the way people live and work and perhaps in the way they think. Singapore, like many other countries, is seeking out technology for economic restructuring and is moving inexorably into the information society in which information networks and databanks will be the arteries and heart of economic and social life.

5.1.3 In Singapore, IT will permeate all walks of our lives – work, home, education and leisure – and will have great impact on our society and culture.

5.2 IT AT WORK

5.2.1 The application of IT as a productivity tool to achieve quantum increases in productivity within each organisation will become commonplace in all industries. Also, the use of IT to maintain strategic competitiveness will be widespread. The proliferation of computers, databanks and information networks will allow timely and accurate processing, packaging, transmission and reception of information in the most efficient and effective manner.

5.2.2 The application of IT in the office environment not only merely allows automation and mechanisation of existing manual systems but, more importantly, also allows innovative reorganisation of work and flow of information within the office and without. Through mechanisation of the office, the organisation can achieve greater efficiency by eliminating redundant work and labourious manual filing. Additionally, the organisation can better utilise its scarce human resources for tasks that require judgement, initiative and rapid communications thus enabling faster and better decision making. Hence this mechanisation will result in full exploitation of teleworking saving both time and other resources. It is only through innovative redesign of work and information flow that substantial improvements in productivity can be achieved. The office of the future combines terminal-based workstations, continuously updated databases and telecom-

munication to attain high efficiency. Each employee could then have a workstation linked to the host computer in the office for sending and retrieving information.

5.2.3 With office work centred on the workstations, there is no longer a need to have all the employees assembled at the same place and time to do their work. This is the virtual office of the future which can extend to the point where the employees are able to communicate remotely with the office proper using portable terminals plugged into the telecommunication network. The virtual office allows teleworking or telecommuting for the employees who can work at home or at work centres set up near their homes or housing estates. The individual workers can therefore organise their own time and decide where and when they want to do their work. The physical office will continue to remain a part of the working life in that it provides a home for the organisation, houses the host computer and serves as a place for face-to-face meetings.

5.2.4 Working life in the service industry such as retail outlets, hotels, tourism and restaurants will also be greatly affected by IT. For instance, the use of optical character readers connected to a computer will greatly speed up the servicing of customers at sales counters, and at the same time reduce the high labour content so characteristic of such establishments. Instead of writing down the order item by item, waiters would just press the correct buttons on their portable "electronic ordering pad" and the orders would immediately be transmitted to the chef's computer. Automation in the kitchen will in turn reduce the number of assistant chefs required. The possibilities are endless.

5.2.5 In factories, robots will be a common sight and the trend will be towards fully automated factories. Today they supplement the workforce in undertaking either health hazardous or highly monotonous jobs. Eventually robots will take on sophisticated jobs when they have built-in vision systems, tactile systems, sensing systems, programming and control systems.

5.2.6 Empirical studies and Singapore's experience indicate that there is no resistance from workers in having robots in the factories. Workers do not object to robots deployed in new work areas but they nurse a lingering fear that eventually robots will replace them.

5.2.7 The implication is that the information society will have less jobs for workers in the manufacturing sector. Those who are in the manufacturing industries are likely to be highly qualified engineers and technicians. The service sector will be the largest absorber of the labour force. With less opportunities for traditional manufacturing and clerical jobs, new jobs will be created with some directly connected to the new technologies and others made possible because people are free to devote their time to services such as caring services, nursing and education.

5.3 CHANGES IN WORK PATTERNS

5.3.1 A major change in work patterns will centre on the growing acceptance of teleworking in society. Teleworking frees the employees from the confines of the office and has economic and social implications. Some of the positive changes of the work patterns are:

- a) Traffic congestion is reduced because of minimal travelling to the office. The savings from reduced travelling and lower maintenance of owner-vehicles can be used for other personal expenditure.
- b) Through teleworking, jobs are moved to the workers and they can reach the married women who are out of the labour force to look after their children and physically handicapped persons who are not in the labour market. The effect is that teleworking increases labour force participation rate by adding on workers who would not have been able to enter the labour force under normal circumstances.
- c) Telecommuting contributes to the development of work ethics as the employees who are unsupervised have to internalize the value of responsibility in performing their work away from the office. Studies in the US have shown that telecommuters usually live up to that trust and tend to be more diligent in teleworking. The studies show that the support staff of typists and clerical workers are more productive. For professionals whose work do not involve much social interaction such as scientists and programmers, there is evidence to show that they achieve higher work productivity. For management staff, their productivity is less easily quantified and many of the tools for telework are not tailored to higher level of work.
- d) As telecommuting cuts across space and time, it implies that jobs can be exported in the form of consultancy and technical expertise without the experts having to travel overseas. The result could be an influx of job opportunities from overseas for the Singapore professionals.

5.3.2 Some of the negative effects arising from the changes in the work patterns are:

- a) Workaholism will be common as the flexible working hours in the home office may lead to employees putting in more hours of work. The social function of home and office becomes inseparable.
- b) The physical absence of employees does not enhance the corporate image. The employees will be more loyal to their work than their companies. Teleworkers may lose their corporate identity and subsequently the corporation may have higher labour turnover rates.

- c) While teleworking enhances the work ethics, it deprives the employees of the social opportunity to interact with colleagues face-to-face. It is difficult for the average worker to sacrifice on-the-job social contacts.

5.4 IT AT HOME, LEISURE AND PERSONAL SERVICES

5.4.1 The application of IT at home and for leisure will be revolutionary and manifold. The videotex system offers opportunities for home transactions with respect to banking, shopping, buying and selling stocks, current information, education and other services. The technology of videotex is available currently but the markets for such services are still undeveloped. Studies in US, UK and Japan show that videotex users are reluctant to pay for the services which can be hefty as they have to pay a fixed monthly subscription fee and hourly charges.

5.4.2 For the pursuit of leisure, databanks will provide a comprehensive range of services from tours, theatres and cinema shows to games and sports, and library catalogues. New personal service industries may be built around the pursuit of leisure and self improvement. Examples are on-line educational programmes for self-study and hobby programmes such as home decoration, car repair and maintenance, music appreciation and home gardening.

5.4.3 In the home of the future, banking will go beyond the logical extensions of ATMs and checking of account balance to the transfer of cheques over telecommunication lines. In electronics cheque transfer the customer enters the amount, name of payee and other pertinent information in the home computer and sends it to the bank for onward transmission to the recipient.

5.4.4 Eventually, the greatest change of technology on consumer behaviour will be the development of teleshopping. This development could lead to:

- a. less importance of town centre shops in the housing estates;
- b. increased business by warehouse sales organisation and by organisations specialising in telesales; and
- c. new home delivery service industries to meet the needs of having full value to be obtained from the remote ordering of deliveries.

5.4.5 In personal services such as health care, legal advice and education, expert systems may see the use of intelligent systems to act as surrogates for professional expertise. These expert systems based on Artificial Intelligence will not only provide a service but will also change the social relationship of the professions or institutions concerned. If general practitioners or nurses can use AI programs in medical health care, then the status and social image of the specialist physicians may be profoundly affected. Legal responsibilities for medical decisions may be assigned in a way very different from today. Likewise, legal AI programs may undermine

the status of lawyers and alter the nature of their work. The general public may come to be less dependent on human experts than they are today.

5.5 SOCIAL PROBLEMS AND INFORMATION SOCIETY

5.5.1 Unemployment

The fear of unemployment is a reality for blue-collar workers and the support-level office workers, particularly the typists and clerical workers. Generally, unemployment will be felt most by women workers who, in comparison with the male workers, have lower education and constitute the bulk of low skilled labour. However, with retraining and the creation of new jobs in the service industry the issue of unemployment need not be a serious problem. Empirical evidence up till now points out that countries such as Japan and Sweden which have the highest level of robots per employee have very low rates of unemployment.

5.5.2 Computer Crime

1. Banks and other financial institutions are targets for computer crime because of the increasing use of EFTPOS to move huge sums of money among banks with electronic symbols as the only record. These codes falling into the wrong hands will unlock the flood gates for financial theft.
2. In the information society, information is a corporate resource for business planning and decision making. The wealth of information stored in the IT system is a target for information theft.
3. Many of these information frauds can be accomplished by manipulating the computer's operating system. By obtaining a master account number, the trespasser can copy or change data, change programs and literally cause havoc to the systems.

5.5.3 Privacy

In an information society, nearly all the personal particulars of individuals are kept in databases by government departments, such as the schools, the hospitals, and the Immigration Department. With the network highways, information pertaining to the individuals can be moved swiftly across the country. If not properly protected, these electronic activities can be wide open to abuse.

5.5.4 Health Hazard

There are conflicting reports with regard to the health hazards arising from prolonged use of display terminals. Some states in the US have proposed legislation which bars pregnant women from working on the keyboards as a precaution against maternal health complications. Work is still going on in medical laboratories to ascertain the dangers posed by radiation from the display terminals.

5.6 IT IN SOCIETY

5.6.1 Despite the anticipated social problems, Singapore cannot avoid becoming an information society. The strategic position of Singapore as an international telecommunication node, the openness of the economy to international influences, the desire for a higher standard of living and the push to be a brain centre blends well with the requirements of becoming an information society, the society of the future. To prepare Singapore society for the information age, the people will have to change their attitudes to recognise the importance of IT in their way of life in order that IT can be exploited and harnessed for greater social and economic development.

CHAPTER VI IT : A NEW BLOODLINE FOR SINGAPORE ECONOMY

IT is the answer for a strong and competitive economy capable of high productivity performance

6.1 INTERNATIONAL SCENE

6.1.1 Both developed and developing countries are gradually coming to terms with the fact that their economic growth will be increasingly tied to the use of new technologies to revitalize traditional industries and to produce new products and services. While some countries have formulated plans to target their priority areas, other countries are either in the process of coming out with their plans or waiting to emulate suitable models for restructuring their economies.

6.1.2 The international markets for exports are very competitive. Third world countries which used to be markets for manufactured goods are now flooding the international markets with their own manufactures such as textiles, semiconductors, consumer electronics and light industrial products. Countries such as Taiwan, South Korea and Singapore are in fact competing with the developed countries in computer peripherals, computer services, shipbuilding, and other products for which the developed countries would like to preserve their competitive advantage.

6.1.3 The US and Western Europe with higher labour costs are casualties in the competition with Japan in particular and the NICs to a certain extent. The John Young Report which examined US international competitiveness, recommended, among other things, that technology would have to be a basis for US economic supremacy.

6.1.4 Technology, according to the report, can revive traditional industries. The concept of sunset industries does not apply if new ways of doing things can be used to bring about more cost-effective production. The US can overhaul its sagging industries because there is considerable R&D and innovation in the country, making it possible to commercialise and apply new technologies. To the US, the issue of technology is not only for economic competitiveness but also for national survival and military leadership.

6.1.5 Japan and Western Europe are also giving strong attention to technology for economic development and comparative advantage in their international trade. Several MITI-sponsored technology development programmes have been completed successfully and several more programmes are in the pipeline. Western Europe led by France, UK and West Germany also pursue national and cooperative technology programmes to exploit new technologies for scientific, commercial, industrial and military purposes.

6.1.6 Other countries, particularly Taiwan, South Korea, Australia, China and India are keen to exploit technology for their economic development. Taiwan and South Korea have aggressive programmes targeting for the development of specific technology-based industries, such as IT hardware production.

6.2 IT IN SINGAPORE ECONOMY

6.2.1 In Singapore, our economy is undergoing restructuring to move away from labour intensive low value added activities to those activities which make more efficient use of our manpower resources in combination with automation, mechanisation and computerisation. The move to restructure the economy is correct as our economy is losing competitiveness, particularly to other Third world countries which have lower labour costs. Singapore has first to increase its productivity in order to achieve competitive edge in existing products and services. Secondly, Singapore has to explore the creation of new products and services.

6.2.2 IT addresses the two issues confronting Singapore: when used together with upgrading of skills, IT increases productivity and when properly exploited, IT can create new products and services. Of all the technologies, IT is one of the most promising in promoting economic growth. IT is applicable in all the economic sectors to enhance competitiveness through its impact on some of the following:

- 1) Lowering cost of production. Some examples are:
 - a) New goods can be produced by using the existing automation system. This has been demonstrated by a Japanese camera company which built an add-on feature to its main automation line for the purpose of handling materials and spare parts to produce low-cost copier assembly systems.
 - b) Services which require extensive documentation can be provided at lower cost. It has been shown in the US insurance industry that IT reduces the cost of underwriting large contracts. Less time is required in preparing the documents and less insurance partners are needed to jointly underwrite the large projects.
 - c) Less labour content is required in business operations.
 - i) In the manufacturing sector empirical studies show that one robot can do the work of 1.7 to 6 workers. With less labour required in automated production, it is easier to have a third-shift working system for the factories to operate round the clock.
 - ii) In the commerce sector, studies in the US show that telemarketing reduces the number of sales people and marketing is more effective with the retailers reaching out to a wider customer base.

d) Less space is required for business operations and thus companies save on rental costs. In the service sector, the concept of virtual office made possible by networking suggests that employees can work outside the office and the office need not have to be located in prime areas.

2) Promoting product differentiation as well as enhancing quality of service through differentiation in carrying out business operations.

a) With IT, products can be customised to meet the specific requirements of clients such as customised designs for chips, manufacturing equipment and consumer durables.

b) Differentiation is also achieved by increasing the information content of a physical product. Examples are:

i) Distributors of products provide on-line service for customer query in after sales equipment maintenance.

ii) Vehicle manufacturers instal IT-based components in vehicles to process information on the safety aspects of manoeuvring the vehicles.

c) Creating wider markets:

i) By allowing business to expand across geographical boundaries without losing the ability to coordinate far-flung operations. Example : electronic publishing of newspapers and magazines via satellite transmission.

ii) By establishing interrelationships with other industries that were previously separated from one another. Examples : In retail business, EFTPOS moves the retail outlets and consumers closer to the banking community. In US, General Motors, a car manufacturer acquired Electronic Data Systems, a computer service company to strengthen its capability in exploiting IT.

d) Spawning new business by making available new products and services. Examples of new business made possible by new technology are electronic mail and videotex. Examples of new business generated within existing companies through the successful exploitation of IT:

i) Companies using state-of-the-art technology in CAD/CAM can sell their excess expertise to industries in need of CAD/CAM systems. In the US, aircraft manufacturers and oil exploration companies offer their expertise in managing IT systems to other industries.

ii) Supermarkets using bar-code scanning to record and itemise purchases made by consumers can sell the informa-

tion of sales transactions as a by-product to market research companies.

6.2.3 Not all the industries can exploit IT and of those which can do so, some of them require more IT than the others. We have examined several avenues to gauge the impact of IT on industries and found the "Strategic Grid" developed by Professor Warren McFarlan of the Harvard Business School a useful model.

6.2.4 From the Strategic Grid model, we have tentatively identified several industries in Singapore in terms of their dependency on IT and the strategic impact of IT on their business operations (Table 6.1). In the Strategic Grid, there are four cells denoting the relationships between the dependence of industries on IT and the impact of IT in the following ways:

- 1) Industries located in the "STRATEGIC" cell are highly dependent on IT as a critical factor for success. For these companies their day-to-day business or manufacturing activities are embedded in the IT use. This implies that the industries which use better IT will have the competitive edge.
- 2) Industries in the "FACTORY" cell are highly dependent on IT support for smooth operations. IT is essential for the industries survival but IT does not give the industries a competitive edge because IT is a way of life for these industries as well as their competitors.
- 3) Industries in the "TURNAROUND" cell currently do not depend absolutely on IT use to achieve their short-term or long-term objectives. But the IT applications under development are vital for the industries strategic success because the impact of IT will change the ways of how the product and services are produced as well as achieving product differentiation. Currently, the industries may not be using IT extensively but in future, without IT, the industries will suffer competitive disadvantage.
- 4) Industries in the "SUPPORT" cell do not depend on IT now and in the future for smooth operations or as a factor for strategic success. IT has a negligible impact on the industries as a whole and IT is not going to change the way of managing a business.

6.2.5 In our perception of IT as the new bloodline for the economy, it is important to emphasize the use of IT for those industries located in the "Turnaround" grid. Some of the reasons are:

- 1) In US, Japan and Western Europe, those industries we have identified in the Turnaround grid are increasingly using IT as a competitive tool. These countries will set the pace and alter the rules of competition in their favour through the exploitation of IT. Unless the Singapore industries use IT, they will lose out in competitiveness.

TABLE 6.1

STRATEGIC GRID

Low	Strategic Impact on IT	High
SUPPORT	<p>Textile/Wood</p> <p>Storage/Warehouse Real Estate</p> <p>Services Allied to Transport</p>	<p>Education</p> <p>Precision Engineering Postal Medical/Health Machine/Tools Robots Industrial Machinery Hotel</p>
FACTORY	<p>Accounting/Auditing</p> <p>Air Insurance Speciality Chemicals Petroleum Refinery Petrochemicals Pharmaceuticals</p>	<p>TURNAROUND</p> <p>Retail Legal Land Transport Electrical Consumer Electronics Heavy Engineering</p> <p>Advertising Market Research Publishing Engineering Architectural & Technical Services</p>
STRATEGIC	<p>Printing Financial</p>	<p>Computer Services Telecoms Industrial Electronics</p>
High	Dependency on IT	Low

2) Unlike the industries positioned in the "Strategic" and "Factory" grids which are already using IT in a significant way, the industries in the "Turnaround" grid are relatively new to IT applications. Industries in the Strategic and Factory grids are able to keep abreast of the developments of IT applications in the leading countries and adopt some of the latest applications. The same cannot be said of the industries in the Turnaround grid to go about using IT.

6.2.6 While the Strategic Grid identifies industries and their dependence on IT for competitiveness, another model developed by Professor Michael Porter of the Harvard Business School is, in our opinion, a useful basis of how industries can examine their business operations for IT applications.

6.2.7 The principles of this model (value chain) are as follows :

1) Companies can be analysed in terms of a series of interrelated activities.

2) Each activity contributes value to the whole business operation from the creation of products and services to the entire infrastructure of the companies.

3) Altogether there are nine value activities in a company and each activity uses information and technology of which the most pervasive is IT to support the whole operation of the company.

4) The interdependence of the value activities have linkages which imply that how a value activity is carried out affects the cost and performance of the other value activities. By managing these linkages, a company can achieve competitive advantage through lower cost, differentiation of product and service and bigger market share.

6.2.8 The value chain model and the Strategic Grid can be used effectively by experts in the industries who have the business knowledge to examine how IT can be incorporated in their business operations (Table 6.2 and 6.3). In this study, we can only provide brief highlights of the impact of IT in the economy as discussed in the subsequent sections.

6.3 IT IN THE MANUFACTURING SECTOR

6.3.1 IT is increasingly used in all aspects of the manufacturing process : engineering, design, component production, assembly, testing, quality control and inventory management. Each of these functional areas has been undergoing productivity improvements through the use of computers and automated equipment. Computer Integrated Manufacturing (CIM) has pulled together all these "islands of automation" in order to realise the full potential of automation.

TABLE 6.2

EXAMPLE OF IT APPLICATIONS IN MANUFACTURING SECTOR

PRIMARY ACTIVITIES (Activities in the physical creation of a product, its sale, delivery and follow up in after sales)						SUPPORT ACTIVITIES (Activities to support Primary Activities)			
INBOUND LOGISTICS	OPERATIONS	OUTBOUND LOGISTICS	MARKETING AND SALES	SERVICE	FIRM INFRASTRUCTURE	HUMAN RESOURCE MANAGEMENT	TECHNOLOGY DEVELOPMENT	PROCUREMENT	
Receiving, Storing and distributing inputs e.g. Automated Warehouse	Production line e.g. Flexible Manufacturing	Handling all aspects of finished product e.g. Automated Order Processing	e.g. Telemarketing and remote terminals for sales persons	Installation at customer sites, repair and user training e.g. remote servicing of equipment. Computer scheduling and routing of repair trunks	General Management e.g. Planning Models	Personnel Matters e.g. Automated Personnel Scheduling	Research Activities e.g. Computer-Aided Design	Input Purchasing e.g. On-line procurement of parts	

TABLE 6.3

EXAMPLE OF IT APPLICATIONS IN SERVICE SECTOR

(As illustrated in Market Research Industry)

PRIMARY ACTIVITIES (Activities in the physical creation of a product, its sale, delivery and follow up in after sales)						SUPPORT ACTIVITIES (Activities to support Primary Activities)			
INBOUND LOGISTICS	OPERATIONS	OUTBOUND LOGISTICS	MARKETING AND SALES	SERVICE	FIRM INFRASTRUCTURE	HUMAN RESOURCE MANAGEMENT	TECHNOLOGY DEVELOPMENT	PROCUREMENT	
Receiving, Storing and distributing inputs e.g. Receiving Survey Returns	Production of Reports e.g. data editing, data capture, data processing, tabulation, analysis and report writing	Handling all aspects of completed report e.g. storing processed information in data bases	On-line transmission of report to clients. On-line retrieval by clients and follow-up on-line query	Updating data for clients - on-line transmission and on-line retrieval	General Management e.g. Billing of Clients, Payroll	Personnel Matters e.g. Staff training on data processing and information collation	Research Activities e.g. Electronic Market Research	Input Purchase e.g. Liaising with clients, third party information providers locally and overseas	

6.3.2 Computer Aided Engineering (CAE) and Computer Aided Design (CAD) improve the power of productivity of engineering staff. This has radically reduced the time needed to transform the ideas of engineers into new generations of products. Consequently, the product life cycles have been compressed. Existing companies face more rapid product obsolescence and must catch up with this trend.

6.3.3 Automated product systems are also pervasive in the manufacture of components. Computer Numerical Control (CNC) machine tools, now more user-friendly and cheaper, are replacing conventional ones. Machinists now require more knowledge but less manual dexterity. Worldwide trade-off calculations are being made between cheap production labour and the capital cost of automated system. Many of the calculations have worked out in favour of automation in Singapore and consequently CIM has made inroads in some industries – consumer electronics, integrated circuit assembly and test, etc.

6.4 IT IN THE SERVICE SECTOR

6.4.1 In the service sector, the exploitation of IT is closely related to the use of networking in bringing about a new way of doing business particularly in those industries which are information intensive. Among these industries are the following:

6.4.2 **Medical and Health Care Industry**

The computerised hospital system is an illustration of how IT can be exploited to support a service sector. Singapore is fast becoming a regional medical centre. This industry can be enhanced by having a national computerised hospital system which links up the public and private hospitals in Singapore and at the same time the network is hooked up to an international network of hospital systems overseas. Among other things, the hospital systems can serve the following purpose:

- a) local doctors in treating patients who have received medical treatment abroad previously can access overseas hospital records for the patients to check their medical history and past prescriptions. Similarly local doctors in treating patients who had treatment in another hospital in the past in Singapore can follow through with their treatment.
- b) By logging on to overseas databases, local doctors can refer their patients in need of treatment overseas to the proper hospitals and specialists there.
- c) With a more efficient health sector through the use of IT, people in the region who have the means for up-to-date medical services will come to Singapore. Indirectly the use of IT in this perspective also generates multiplier effects for the economy. For example overseas patients coming to

Singapore may fly by SIA, stay in hotels, do their shopping, travel by taxi while in Singapore and make use of recreational facilities.

6.4.3 **Publishing Industry**

In the publishing industry, IT is also changing the way the industry positions itself to take advantage of the new technology. Singapore is fast becoming a publishing centre for electronic publishing as seen in the presence of the Asian Wall Street Journal, the Economist and Times Magazine which use Singapore as the node in the printing of their news materials. What is happening in the US and Western Europe is that IT has potential for providing a new media to store published materials, now in the form of diskettes, and a strong move to access publications in electronics form by accessing databases. This is a new industry and the form of electronic publication offers itself as a strong challenge to the conventional way of publication and reading. Singapore can exploit this new area of the publishing industry.

6.4.4 **Market Research Industry**

In market research, the US, Japan and Western Europe are using IT to source, collate, transmit and sell market intelligence to customers. Of all the markets in the world, the Asia Pacific market, particularly the Asean markets, has little information for potential entrepreneurs in the US and Western Europe who may want to invest in the region. Here is an opportunity for Singapore to use IT as a potential tool in a networking environment to build up a strong information industry, covering market intelligence and other related aspects of commercial, industrial and investment information of the region.

6.4.5 **Retail Industry**

6.4.5.1 IT is making its way into the retail industry in the form of electronic shopping. In the US, Japan and Western Europe teleshopping and EFTPOS are beginning to emerge in the retailing business. In Singapore an EFTPOS project is under way in a trial run involving the local banks and major retail outlets. When the Televue system is implemented, teleshopping in Singapore will provide a new dimension in retailing activity.

6.4.5.2 Currently electronic shopping is a novelty but in the cashless society of the future, it will be a competitive tool. IT in the retailing business has several applications such as:

- i. automatic purchasing by consumers who can order items from a computerised catalogue stored in a database network;
- ii. automatic ordering by retailers to secure supplies from manufacturers or wholesalers;
- iii. computerised selling in which transactional terminals are marketing tools for sales such as cosmetic and fashion wear.

6.4.5.3 Electronic shopping will alter the structure of the retailing industry in the following ways:

- i. There is less need for shelf space as inspection of items can be done on remote terminal screens in homes and hotels;
- ii. Fewer sales persons such as store clerks, cashiers and demonstration staff, are required; and
- iii. Less space for inventory as management has instant information on what are the items that are moving fast and what items are not doing well as dictated by consumer preferences.

6.4.6 Hotel Industry

6.4.6.1 IT will enhance the role of hotels as a focal point in promoting tourism. This can be done in the following ways:

a. Information Enquiry

i. Presently, tourist information on Singapore available at hotels is in the form of brochures or pamphlets. By using IT, hotels can provide enquiry terminals installed in the hotel rooms or in the lobbies for their guests to access online information on tourist attractions. This information can be in the form of audio-visual presentations.

ii. Similarly, for Singapore to project its tourist image as the gateway to Asean and the Far East, enquiry terminals with access to databases such as general geography and tourist spots of these countries can be a strong promotional tool for Singapore as a stopover point in the Asia Pacific region.

iii. Enquiry terminals can also be linked to the airlines or travel agencies to allow tourists to confirm their flight reservations or to book flights to other destinations. The travel agencies can also provide on-line information of their tour programmes or land transportation services.

b. Business Travellers' Facilities

i. One of the strategies in promoting tourism is to establish Singapore as a convention centre. IT application can enhance this role by providing the capability for international and regional videoconferencing.

ii. As data communication will be an important feature in carrying out business transactions, the hotels can also provide facilities that will allow business travellers to plug their portable microcomputers into the telephone system for communicating with their business associates in other countries.

6.4.7 **Legal Sector**

6.4.7.1 The legal profession is a heavily information-intensive industry that relies on legislation and case law to a great extent. As an industry, the legal profession is an important support industry to all the other economic sectors.

6.4.7.2 For the legal profession, IT can be used for the following activities:

- a) accessing a central database on case law and legislation statutes to save time in looking up the relevant legal documents. Case law databases are already available in the US, UK and other countries. In Singapore, the Law Society, the Faculty of Law and the AG's Chambers are currently looking into the feasibility of starting up such a database;
- b) word processing for preparing legal documents such as drafting of wills and contracts;
- c) electronic publication of law journals; and
- d) An expert system for clients to seek legal information before consulting lawyers to take up their cases.

6.4.8 **Education Sector**

6.4.8.1 Education technology is increasingly exploited in many countries such as the US, Western Europe and Australia. In Singapore, IT has a role to play to enhance teaching and learning skills. The current education system will see students spend a longer time in schools and IT can help to supplement teaching resources.

6.4.8.2 In the US, typewriting is compulsory in some schools. Learning to use the typewriter prepares the students later on to acquire keyboard skills quickly. Some colleges in the US make it compulsory for students to own microcomputers. This again is to prepare the students for working life in which the use of IT will become more prevalent.

6.4.8.3 For IT to be exploited effectively, there is a need to set up an education network which, among other functions, will allow students and teachers to access education materials such as:

- a. subject databases for research and enquiries;
- b. storage and retrieval systems for libraries;
- c. independent self-study module databases;
- d. CAI databases for the learning of mathematics and science subjects;
- e. graphic systems; and

f. electronic communication in the form of electronic bulletin boards.

6.4.8.4 The databases can be accessed from schools as well as homes to provide a continuous learning aid for students and a teaching guide for teachers.

6.5 SPIN-OFFS IN IT APPLICATIONS

6.5.1 In using IT in manufacturing electronics and electrical engineers who become proficient in IT use can export their services in the form of consultancy and retooling expertise for overseas users. This expertise can take the form of technical expertise in robotics, CAD, CAM and CAE in combination with business know-how.

6.5.2 The marine industry and the aircraft-related industries can create databases of ships and aircrafts coming into Singapore for repairs. The databases can also include the history of the ships and aircrafts and such databases can be sold to interested party such as used-vessel and used-aircraft buyers.

6.6 NEW INDUSTRIES

6.6.1 In the auto industry, there is a market for IT components such as built-in radar equipment which alerts drivers of danger on the roads and radio-dials which inform moving cars to respond to call signals. Our auto industry which specialises in the manufacture of the electronic components for cars can develop some of the new products in the industry.

6.6.2 In the electronics industry, optical disk is becoming important and there is potential to build up a strong optics industry. In laser optics Singapore can invest to develop applications for lasers in the whole disk system. There are local engineers who have the knowledge and expertise to design Winchester drives. With their knowledge of the core technology, the local engineers can participate with the MNCs to develop Winchester disk drives of 30 milliseconds at the higher end products and 70 – 80 milliseconds at the lower end products.

6.7 IMPORTANCE OF NETWORKING

6.7.1 Networking, in short, is the backbone for revitalising our existing industries and through the opportunities offered by the new technology, new businesses can be spawned in the form of information providers selling their knowledge packaged in databases for retrieval over the network. There are endless opportunities to create new services using IT ranging from IT applications in the service sector to the manufacturing sector.

6.7.2 To round up the importance of networking for competitive edge, Singapore should have a business intelligence network for our local companies. This network can be linked to Singapore trade offices overseas, the headquarters of EDB and TDB and international market research organisations to source information for business decisions and planning. It is also possible to link this business intelligence network to the public research organisations for information on technology trends and prototype products which can be commercialized by the private sector.

6.8 THE NEED FOR AN IT ORIENTED ECONOMIC STRATEGY

The opportunities offered by IT are tremendous both in terms of providing our economy with a new strategic thrust as well as the impact on our quality of life. Our increasingly educated workforce with strong emphasis on technology, our strategic location, our belief in human resource management guided by pragmatic and far-sighted government leadership are all necessary critical success factors for exploiting IT for economic and social gains. To fully capitalise on the opportunities available, we need to formulate an IT oriented economic strategy. A highly focussed and integrated IT strategy will be an indispensable component of our new economic strategy for the 1990s and beyond.

CHAPTER VII AN INTEGRATED IT STRATEGY FOR SINGAPORE

WE NEED AN INTEGRATED IT STRATEGY TO CONSTITUTE AN AGENDA FOR ACTION TO UNITE THE EFFORTS OF VARIOUS ORGANISATIONS SO AS TO REALISE THE FULL ECONOMIC AND SOCIAL POTENTIAL OF IT IN SUPPORT OF THE NEXT PHASE OF OUR NATION BUILDING

7.1 WHY AN INTEGRATED IT STRATEGY?

7.1.1 IT is vital to our economy. It is very clear now that the main challenge confronting us over the next few years is to revitalise the economy to regain our international competitiveness.

7.1.2 IT can help us to achieve this quantum leap in productivity. Through IT, an improvement of many orders of magnitude in efficiency and effectiveness is possible :-

- a) we can automate clerical routines and operational procedures to achieve a new level of work performance;
- b) IT can help us to improve our present working method or even introduce new ways of doing things;
- c) by integrating the power of computers and telecommunications, new information handling approaches have opened up many new possibilities in businesses;
- d) business transactions need not be restricted to the confines of the location of the business; and
- e) IT will offer us new ways of doing marketing and retail.

7.1.3 Faced with pressure from international economic forces, all our economic sectors have to examine how they can use IT as a productivity tool to enhance their competitive edge. Those who are not able to respond to the demand of this wave of technological change will be left to perish in economic backwaters. The ones who will succeed are those who can ride with the wave of technology, spot new opportunities and reposition themselves to capitalise on the new challenges.

7.1.4 If we want to maintain and enhance our standard of living, we must be able to achieve major breakthroughs in productivity improvement. The potential presented by IT is tremendous both as a productivity tool as well as a new way to make a living.

7.1.5 As we move into the information age, IT will permeate our working lives, homes and society at large. It is no longer a question of whether we should or should not exploit IT. The real issue is, can we afford not to?

7.1.6 If we want to regain our competitive edge, IT is an inescapable economic imperative. Likewise, if we want to survive in the information age, we better learn how to make a living out of IT. There is no way that we can avoid this economic transformation. The sooner we can reorientate our thinking to cope with the challenges of IT, the better it is for every one of us.

7.1.7 IT is so pervasive that it cuts across the boundaries of many disciplines and extends beyond the domains of many different agencies which have responsibilities to develop different aspects of it. We need to have a consolidated approach to deal with IT if we want it to develop into a new economic bloodline.

7.1.8 Over the past few years, our national computerisation effort overseen by the CNC and with the executive support provided by the NCB, has created the infrastructure and conditions necessary for us to take advantage of computer technology. We have made progress. Many organisations have responded positively to the government's call for computerisation. This spontaneous response without proper focussing will dissipate our energy. A fundamentally different approach is now required for us to focus our efforts.

7.1.9 IT is too critical to our future economic well being for its development to be left at the existing fragmented approach of different agencies tackling different aspects without any specific attempt to integrate the efforts of all to achieve synergy.

7.1.10 It is imperative that we must introduce a new consolidated strategy to develop IT so as to achieve its full spectrum of potentialities.

7.1.11 We must transform our national computerisation effort into a new national IT drive based on a co-ordinated approach by drawing upon the strengths of various organisations to enable us to achieve our IT vision of the future.

7.1.12 Such an integrated IT strategy will provide all organisations in Singapore a clear view of the future so that their efforts and energies can be channelled accordingly to exploit IT fully in our next phase of economic and social development as well as to enable us to make a living out of IT.

7.2 A CONSOLIDATED IT STRATEGY

To make IT a vital force of our economy, we shall need to shape its development. It is crucial for us to develop a framework with which to focus our attention on directing IT to realise its full potential in our economic and social development. Such a blueprint will constitute the basis for a new national IT drive and will serve as a highly focussed agenda for action to guide our energy in achieving our IT vision of the future. This calls for a fundamental rethink of our national computerisation effort, namely :-

- a) Areas that we have not yet addressed must now be properly examined and be converted into specific action programmes; and

- b) For IT to permeate throughout our economy and society and to play its role as the new economic bloodline and a new avenue for making a living, we need a well co-ordinated set of actions to unite the efforts of organisations within the public and private sectors.

7.3 7 MAIN BUILDING BLOCKS OF IT STRATEGY

We propose that our integrated national IT strategy shall comprise seven main building blocks, each with a strategic thrust, to serve as the overall impetus for our national IT movement. These seven building blocks embrace the full spectrum of IT activities in Singapore and will provide a definitive direction to guide the development of IT capability in Singapore thus enabling us to achieve our objective of exploiting IT for economic gain as well as to allow us to make a good livelihood from it. Together they will propel Singapore ahead to realise our IT vision and to contribute towards our economic and social development. These seven building blocks are illustrated below.

7.3.1 Strategic Building Block No 1 : IT Manpower

OUR KEY ASSET AND THE MAIN DETERMINANT OF OUR OVERALL IT CAPABILITY. THEY ARE THE HIGHLY SKILLED CHAMPIONS WHO ARE EXPERTS IN EXPLOITING IT TO ENABLE OUR ENTERPRISES TO GAIN THEIR COMPETITIVE EDGE

7.3.1.1 To harness the full power of IT, we need professionals who are fully equipped to deal with technological changes and capable of helping organisations to exploit IT for maximum productivity contribution and competitive advantage. We must produce IT professionals who are well trained in technical and application aspects of IT.

7.3.1.2 Up to now, our computer training institutions are strongly biased towards producing professionals with orientation in commercial data processing. We need to reorientate our curriculum so that our future IT professionals will be well versed in both hardware and software aspects of IT as well as data communication. Engineering students should be exposed to an adequate level of IT in their programmes. Existing computer professionals will also need to be continuously upgraded to deal with new technologies. We must have, in our IT professionals, the full spectrum of skills needed for systems development both in terms of technical and application knowhow. There must be those who understand the management of technology and the entrepreneurial aspect of IT.

7.3.1.3 To propel Singapore ahead into the information age, the training institutions have a most crucial role to play. What we need is to refocus our manpower development effort and to re-examine the quantity and quality of IT manpower that these institutions are producing. IT manpower is our key to successful exploitation of IT. No effort should be spared to ensure that our IT manpower will be of the highest level of competence.

7.3.2 Strategic Building Block No 2 : IT Culture

WE MUST MOUNT A TOTAL APPROACH TO PROMOTE A SUPPORTIVE CULTURE TO PREPARE OUR CITIZENS FOR THEIR ROLE IN THE EMERGING INFORMATION ECONOMY

7.3.2.1 Our ability to exploit IT for economic advantage and to improve our quality of life is greatly dependent on the mental disposition of our citizens towards change and technology.

7.3.2.2 What is needed is a very positive attitude towards IT, fully appreciative of its potentials and the adjustments that will have to be brought about with its extensive use. Our IT vision will not be achievable if we do not bring about the necessary attitudinal change among our citizens.

7.3.2.3 We need to mount a comprehensive IT culture programme to achieve the required level of IT literacy throughout our society starting from school children and to embrace all walks of life to prepare each and every one for the information age.

7.3.2.4 We have to move away from the misconception that IT literacy is about programming. We should make the citizens feel comfortable working with application packages in front of workstations to the same degree of ease as operating a hi-fi-set. It is therefore important to start IT literacy at an early age by incorporating IT exposure topics into the curriculum as early as possible.

7.3.2.5 For users at various levels in the organisations, appropriate user education programmes covering the application aspects and needs identification part of IT exploitation should be introduced. In the tertiary institutions, all students, irrespective of their disciplines, should be given the necessary literacy programmes to enable them to use application packages as their learning tools as well as for personal support purposes such as word processing.

7.3.2.6 Our promotion of IT culture must be total to prepare the country for moving into the information age. We should now adopt a planned approach to bring about a new level of awareness among the public through appropriate mass media activities in order to achieve the desired change in attitude to support our entry into the information era.

7.3.3 Strategic Building Block No 3 : Information Communication Infrastructure

THE BACKBONE OF OUR INFORMATION AGE WHICH WILL BRING ABOUT MANY NEW INFORMATION BASED BUSINESSES AND OPENING UP NEW OPPORTUNITIES FOR ENTREPRENEURS. WE MUST AIM TO CONTINUE TO HAVE THE BEST TELECOMMUNICATION FACILITIES IN THE WORLD TO MAINTAIN A DIFFERENTIAL ADVANTAGE IN THE INFORMATION AGE

7.3.3.1 As the backbone or highway of the information age, telecom-

munications or information communication infrastructure is the enabling facility which interconnects people and machines through voice, text data and image.

7.3.3.2 Singapore today is an acknowledged leader in using telecommunication technology and has one of the most sophisticated telecommunication facilities in the world. Telecoms should continue to invest heavily in advanced facilities and make its rates competitive internationally to provide businesses the necessary edge to survive and compete in the world.

7.3.3.3 New telecommunication facilities such as telemetry, Integrated Services Digital Network (ISDN), televideo, office automation, mobile communication and value added network services which will be introduced progressively over the next 10 years will provide businesses and organisations the new enabling facilities to introduce innovative services for competitive advantage and new level of performance.

7.3.3.4 With the massive investment planned by Telecoms over the next five years, we can be assured of excellent information communication facilities to enable Singapore to exploit IT. IT professionals must be thoroughly trained to exploit such facilities. Telecoms can play more than an infrastructure creation role. It should spearhead many new information services by collaborating with private sector companies and be a leader in the use of IT.

7.3.4 **Strategic Building Block No 4 : IT Application**

TO REVITALISE OUR ECONOMY, ALL ECONOMIC SECTORS MUST TRY TO FURTHER EXPLOIT IT. FOR THE MANY NEW USERS WHO ARE NOT YET INITIATED INTO IT APPLICATION, NEW FORMS OF HANDHOLDING ASSISTANCE MUST BE PROVIDED TO OVERCOME THEIR TECHNOLOGICAL PHOBIA

7.3.4.1 Over the next few years, to give the economy the productivity boost that it needs to regain international competitiveness again, all economic sectors should take advantage of the current slack in the economy to streamline operations, chart a new course to re-establish business viability and exploit IT as far as possible for strategic advantage.

7.3.4.2 New businesses that will emerge particularly in the service sector are likely to be heavily dependent on knowledge workers. The high value added brain services with their dependence on expensive and high powered "gold collar" workers should be provided with appropriate IT tools such as engineering workstations to augment their capability.

7.3.4.3 The public sector should continue to take the lead in the use of IT. Over the past four years, the Civil Service Computerisation Programme (CSCP) has established a firm expertise base within the Civil Service in computer applications.

7.3.4.4 A long range plan is now being conceived to define the direction for the next stage of CSCP. The objective is to make the public sector responsive and efficient and to provide a new standard of public service with a strong public orientation covering both business and the general public and to support the private sector as the key engine of growth.

7.3.4.5 In the next stage of CSCP implementation, specific opportunities will be identified to allow the private sector, particularly the local software companies, to participate in the development of application systems. The capability so developed can ultimately be exported using the private sector as the vehicle.

7.3.4.6 By encouraging the public sector to adopt a less in-house orientation, more software business can be generated for the private sector to establish their strength and capability. The computer services industry, however, should set its sight at attaining international market capability through addressing the larger needs of the private sector market.

7.3.4.7 The most exciting opportunity for exploiting IT will emerge in the private sector. The challenge is to get every economic sector to actively pursue a strategy of IT exploitation through handholding provided by competent computer services companies and with incentives provided by the government. The economy will emerge stronger and fitter through this active phase of IT exploitation and a competent IT industry will evolve with acknowledged capability in applying IT to the manufacturing, service, transportation and all other sectors.

7.3.5 **Strategic Building Block No 5 : IT Industry**

A STRONG IT INDUSTRY WILL BE THE MAIN DRIVING FORCE TO PUSH THE ECONOMY TOWARDS A HIGHER LEVEL OF PERFORMANCE. MAXIMUM ENCOURAGEMENT MUST THUS BE GIVEN TO PROMOTE THE DEVELOPMENT OF A POWERFUL IT INDUSTRY

7.3.5.1 Central to the IT strategy is the need to have a viable, broadly based and thoroughly competent IT industry. The IT industry has three constituent industries, namely, the computer services industry, the computer hardware manufacturing industry and the telecommunication services industry.

7.3.5.2 Our IT industry development strategy should aim at attaining a right balance of indigeneous and external expertise. The multi-national companies will continue to be the main agent for the transfer of technology. It is important, however, to develop our own expertise in interpreting and processing various information technologies to lead to their successful exploitation in our economy.

7.3.5.3 The microelectronic industry with its great dependence on multi-national companies is unlikely to deviate from its previous development pattern. Our strength in being able to respond to technological movements fast will remain a key factor influencing investors' decision to

locate their manufacturing plants here. With the growing integration of design and manufacturing through computer integrated manufacturing (CIM), shorter product life cycle and increasing automation, hardware manufacturers will likely limit their manufacturing operation at home unless there is a specific requirement to locate the plants near where the markets are as dictated by an increasing trend in protectionism worldwide. Our manufacturing part of the IT industry will have to move up market to concentrate on the design and high value-added aspect and maintain our capability to respond quickly to technological changes so as to continue to attract overseas investment.

7.3.5.4 Our telecommunication services industry, the development of which is fully entrusted to Telecoms, plays a strategic role in determining the competitiveness of the other two related industries. It is important to ensure that our telecommunication policies and development will continue to support the development of the entire IT industry.

7.3.5.5 As for the computer services industry, it is still in its infancy. New incentive schemes specifically tailored to its needs are now required to provide it the push. The ability of the industry to grow as envisaged by the Computer Services Industry Working Group is dependent on the degree of success achieved by the various economic sectors in exploiting IT which will generate demand for IT products and services provided by the industry. Only through a carefully planned handholding strategy with clear cut demonstrated results will organisations be willing to invest and further invest in IT. The ability of the industry to meet this challenge will influence its fate and the eventual attainment of the export orientation objective.

7.3.5.6 The recommendations of the Computer Services Industry Working Group to exploit domain expertise, to open up test beds within the public sector to allow the computer services industry to participate in system development, the free flow of resources between the public and private sector, strategic alliance with international leaders and the emphasis on niche marketing and strong marketing capability are all important aspects of developing this industry.

7.3.5.7 With IT being identified as the new economic bloodline, the IT industry has the most crucial role to play to support the economy in its quest for higher productivity and new competitiveness and to evolve into a sectoral industry by itself.

7.3.6 Strategic Building Block No 6 : Climate For Creativity And Entrepreneurship

A STIMULATING ENVIRONMENT WHICH PROMOTES CREATIVITY AND ENTERPRISE WILL BE THE PREREQUISITE TO ENABLE US TO TRANSFORM OURSELVES INTO AN INFORMATION ECONOMY

7.3.6.1 Another essential building block of our IT strategy is the need to create a conducive climate for creativity as well as to promote entrepreneurship.

7.3.6.2 To exploit IT innovatively and successfully will require the establishment of a strong base of technical expertise. It is not enough to know how to use and manage IT. To be able to stretch the limit of technology as well as to ride the wave of technological changes, we shall have to develop indigeneous capability in applied research so that we can benefit from advanced technological application.

7.3.6.3 With NUS giving more emphasis to R&D now, the setting up of a Research Division within ISS, the proposed Information Technology Institute within NCB and the various R&D activities of Telecoms will be given its impetus. These applied research efforts should be mutually reinforcing one another with each institute having its own thrust. They should also work hand in hand with the private sector to commercialise the prototypes developed or capability so established. The test beds provided by the public sector for IT innovation can lead to real commercial opportunity provided suitable mechanisms for private sector participation are established.

7.3.6.4 To develop a climate supportive of innovation, bright IT professionals should be given strong encouragement through venture capital financing, incubator facilities and an agreeable social climate. A viable IT industry will not emerge if talents within the public sector are contented to remain behind. A daring spirit of enterprise and risk taking based on strong technological knowhow and business acumen can come about only if the environment allows it. Our education system has its part to play to promote this new spirit required for the information age. The reward mechanism and the supportive culture must be conducive enough to encourage capable IT professionals to take the plunge into business.

7.3.6.5 A suitable framework for the protection of intellectual property is also a key factor in promoting creativity. Efforts of potential software developers should be protected. Respect for intellectual property has to be cultivated from young. Only then will our Singaporeans with talent feel comfortable about channelling their energy in creative pursuits.

7.3.7 Strategic Building Block No 7 : Co-ordination and Collaboration

TO REALISE THE FULL POTENTIAL OF IT, WE NEED TO UNITE THE INDIVIDUAL EFFORTS OF VARIOUS ORGANISATIONS UNDER THE LEADERSHIP OF A NEW NATIONAL COMMITTEE ON IT WHICH WILL EVOLVE FROM THE PRESENT COMMITTEE ON NATIONAL COMPUTERISATION

7.3.7.1 The pervasiveness of IT and the inter-relationship of the constituent industries of the IT industry plus the strategic importance of IT to our economic and social well being suggests that IT development will have to be well co-ordinated. The IT strategy presented in this report will not be complete if the co-ordination aspect is missing.

7.3.7.2 The CNC has been responsible for providing the impetus to our national computerisation effort with the NCB serving as the executive arm. With the new dimension provided by the integrated perspective of IT, a new framework of co-ordination should be established now.

7.3.7.3 The newly reconstituted CNC chaired by Minister of State for Trade & Industry and Defence with representation from NCB, EDB, Telecoms, NUS, Science Council, Ministry of Finance and Ministry of Trade & Industry is the ideal mechanism to provide the overall policy guidance for IT development. The national IT strategy contained in this report can serve as the new blueprint for action for various agencies under the guidance of CNC.

7.3.7.4 The NCB, EDB and Telecoms which are involved in developing different aspects of the IT industry can use the IT strategy articulated as the basis for collaboration. Cooperation at both the board and executive levels are crucial in ensuring consistency in action to achieve maximum result in realising our IT vision. The National IT Plan study effort is a good start in getting all relevant agencies to work towards a common goal. The excellent momentum achieved must be allowed to continue.

7.3.7.5 The CNC should therefore be the policy setting body for our IT movement and should be appropriately renamed National Committee on IT. Each agency embraced by this movement will have its own role to play and its own mission and objectives. The operating philosophy should be to reinforce one another and to seek the participation of other agencies whenever required to move Singapore ahead into the information age. The NCB serving as the executive secretariat of the CNC should therefore seek to realise the collaborative philosophy encapsulated in this IT strategy through appropriate coordinating effort under the direction of CNC.

CHAPTER VIII RECOMMENDATIONS

8.1 The seven building blocks identified in Chapter 7 chart the course for Singapore to realign its national outlook in striving for economic and social development. These 7 building blocks form the foundation for examining the IT industry in a coherent way. They also serve as the framework for formulating policies and strategies in the exploitation of IT to improve Singapore's economic efficiency and to tap new business opportunities.

8.2 We recommend policies and strategies to redress the problem areas under each of the building blocks. Our recommendations are not final and the reconstituted Working Committee in the second phase study will have to look in greater details into the following:-

8.2.1 IT MANPOWER

Formulate an IT manpower master plan addressing the major themes including the following :-

- a) the required number of IT professionals in the labour market over the next ten years;
- b) the role of the computer training institutions such as ISS, DISCS, JSIST and CCS in turning out new IT professionals who have strong technical and business knowledge;
- c) the role of the engineering training institutions such as NUS, Polytechnics, NTI in producing new IT-oriented engineers who are capable of designing software for ICs, telecommunications and networking;
- d) the retraining of existing computer professionals.

8.2.2 IT CULTURE

Adopt a total approach through a comprehensive programme to promote a supportive IT culture and to prepare the people for an information economy. This approach should take into account the following :-

- a) overcoming technology phobia of people;
- b) creating awareness of IT applications in society e.g. the role of demonstration centres to provide hands-on experience for the public;
- c) identifying target groups in the population to match their responsiveness towards IT and the types of IT literacy they require, for example, the use of IT as a teaching tool in school.

8.2.3 INFORMATION COMMUNICATION INFRASTRUCTURE

Telecoms as the central provider and regulatory body for information communication services to :-

- a) introduce new information communication services to enhance the quality of life of the people of Singapore;
- b) continue developing the necessary information communication infrastructure to support the IT industry development;
- c) act as a catalyst to exploit information communication infrastructure to help the private sector improve its competitiveness.
- d) co-operate with the private sector so that the economy as a whole can acquire indigenous capability.

8.2.4 IT APPLICATIONS

The public sector as a major user of IT to :-

- a) continue taking the lead in IT applications by serving as a model to the private sector in exploiting IT as a productivity tool;
- b) provide incentives to the private sector to invest in IT e.g. incentives for organisations to use their sites as a test bed and incentives for small businesses to procure professional IT assistance;
- c) co-operate with the computer services industry to get every economic sector to pursue a strategy of IT exploitation e.g. setting up of demonstration centres showing office of the future, home of the future, factory of the future to allow prospective users to view, understand and experience the impact of such applications.

8.2.5 IT INDUSTRY

Formulate a consolidated strategy for the computer services industry, the computer manufacturing industry and the telecommunication services industry to:-

- a) develop the IT industry as an integrated industry, for example, additional tools for promoting the computer services industry;
- b) identify and exploit market and technology niches not only in Singapore but also in other countries, for example, the public sector open up its test beds for private sector participation.

8.2.6 CLIMATE FOR CREATIVITY AND ENTREPRENEURSHIP

Formulate a national R&D strategy addressing the following :—

- a) development of indigenous capability in applied research e.g. strategic alliance between the university and the private sector;
- b) fostering innovation for IT applications e.g. the public sector as a test bed for application of new technologies;
- c) commercialization of ideas on the development of IT products and services e.g. the private sector to commercialise prototype products from public research laboratories.

8.2.7 CO-ORDINATION AND COLLABORATION

Establish a National Committee on IT evolving from the present *Committee on National Computerisation* to serve as the mechanism for co-ordinating the major organisations responsible for the various aspects of IT to achieve a national IT approach. The National Committee on IT to set the direction in the following areas :—

- a) formulate and review periodically long range IT policies and strategies to support the economic and social development of Singapore;
- b) review and endorse IT action plans and programmes as recommended in the National IT Plan;
- c) provide top level guidance and impetus to the public and private sector in the implementation of their respective action plans and recommendations.

CHAPTER IX FOLLOW UP ACTION

9.1 This interim report marks the end of the first phase study of the National IT Plan. We have drawn attention to the importance of IT in shaping the economic and social development of Singapore and have identified seven building blocks for the development of the IT industry.

9.2 IT is a wider concept than computerisation and it involves several agencies which have come together to pursue a common aim of developing an integrated IT industry through co-ordination and collaboration of their hitherto separate spheres of functions. It should be noted that the get-together of individuals from NCB, EDB, Telecoms and ISS to form a Working Committee bears testimony that separate organisations can share their resources and work as a team to realise a common vision for the country.

9.3 The interim report will serve as a basis for the CNC to adopt a new focus for national computerisation and a new blueprint to bring about effective co-ordination and collaboration among NCB, EDB, Telecoms, ISS and other public organisations to achieve synergy in developing the IT industry and to move Singapore successfully into the information age.

9.4 The second phase study of the National IT Plan will be followed up by a Working Committee which will also include representatives from the private sector as well as other public organisations not represented in the original Working Committee. Special task forces can also be set up to explore in depth topics uncovered by the Working Committee. Arising from the first phase study, the enlarged Working Committee will have to address specific issues of how IT can be effectively applied in each of the economic sectors and to implement the recommendations contained in the interim report by setting specific targets, resources and timing to exploit IT to the best advantage of Singapore.

REFERENCES

TITLE OF PAPER	AUTHOR
10-YEAR IT PLAN -- A STUDY PROPOSAL	NCB
PROCEEDINGS OF BRAINSTORMING SESSION WITH SRI INTERNATIONAL	NCB
PROMOTION OF AN EXPORT-ORIENTED COMPUTER SERVICES INDUSTRY	NCB
IT INDUSTRY IN ASIA PACIFIC REGION : ITS RELEVANCE TO SINGAPORE	NCB
A SURVEY REPORT OF MANPOWER AND SALARY IN THE SINGAPORE COMPUTER INDUSTRY	NCB
A SURVEY REPORT OF SINGAPORE COMPUTER VENDORS 1984 AND 1985	NCB
REVIEW OF SINGAPORE SEMICONDUCTOR INDUSTRY	EDB
IT TEN-YEAR PLAN -- A WORKING PAPER	TELECOMS
TOWARDS AN INFORMATION SOCIETY	TELECOMS
SOCIAL IMPACT OF IT	TELECOMS
KEY TECHNOLOGIES RELEVANT TO SINGAPORE	SUBCOMMITTEE HEADED BY DR WANG KAI YUEN
GLOBAL TRENDS IN THE INFORMATION INDUSTRY	SRI INTERNATIONAL
SILICON VALLEY : SOME SUCCESS FACTOR IN THE SUCCESS STORY	SRI INTERNATIONAL
TECHNOLOGICAL AND BUSINESS CONSIDERATION IN INTERNATIONAL INDUSTRIAL DEVELOPMENT	SRI INTERNATIONAL
IMPACT OF ADVANCED TECHNOLOGIES IN THE WORLD ECONOMY	SRI INTERNATIONAL
THE INFORMATION ARCHIPELAGO -- PLOTTING A COURSE	HARVARD BUSINESS SCHOOL
HOW INFORMATION GIVES YOU COMPETITIVE ADVANTAGE	HARVARD BUSINESS SCHOOL