

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

No. 37

SINGAPORE INSTITUTE OF STANDARDS & INDUSTRIAL RESEARCH (SISR)
THE REPUBLIC OF SINGAPORE

STUDY
ON
DEVELOPMENT OF PACKAGING CENTRE
IN
THE REPUBLIC OF SINGAPORE

SEPTEMBER 1993

UNICO INTERNATIONAL CORPORATION
JAPAN PACKAGING INSTITUTE

TOKYO, JAPAN

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Preface

In response to a request from the Government of the Republic of Singapore, the Government of Japan decided to conduct a study on the Development of the Packaging Centre in the Republic of Singapore and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Singapore a study team headed by Mr. Tetsuo Inooka, Unico International Corporation, two times between November 1992 and July 1993.

The team held discussions with the officials concerned of the Government of the Republic of Singapore, and conducted field surveys at the study area. After the study team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the development of the Packaging Centre in Singapore and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Singapore for their close cooperation extended to the team.

August 1993



Kensuke Yanagiya

President

Japan International Cooperation Agency

September 1993

Mr. Kensuke Yanagiya
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Mr. Yanagiya

Letter of Transmittal

We are pleased to submit to you the final report on the Study on the Development of the Packaging Centre in the Republic of Singapore. The report contains analysis of the present status and issues of the packaging sector in Singapore, the needs the Packaging Center would meet, and the recommendation on the development program for the Packaging Center, with analysis of its financial viability.

In the report, we provide basic recommendations as to the role to be played by the Packaging Center for development of the packaging sector development, and how the Center should meet the needs of the packaging sector. The recommendations are expressed in the following three development thrusts, namely; (1) Giving support to upgrading industries in Singapore through promotion of the advanced packaging sector, (2) Provision of technical infrastructure for packaging development, and (3) Further evolution to Southeast/ Southwest Asian Packaging Center.

The Packaging Center has already started its operations last April. We believe that the Center has already established a foundation for its operation by using the various technical transfer programs provided by our team as a part of the Study, and the equipment used for the Study, which is to be granted to the Center by your Agency with completion of this study. SISIR has expressed its full commitment to building up the Packaging Center to support the development of packaging technology in Singapore. With the implementation of the recommended development program, we are certain that the Center will be able to contribute significantly to the industrial development of Singapore through support in the packaging field.

We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs, and Ministry of International Trade and Industry for the valuable advice and support provided on behalf of this study. We also wish to express our deep gratitude to the Singapore Institute of Standards and Industrial Research and other authorities concerned of the Republic of Singapore for the close cooperation and substantial assistance rendered to us during the performance of this study.

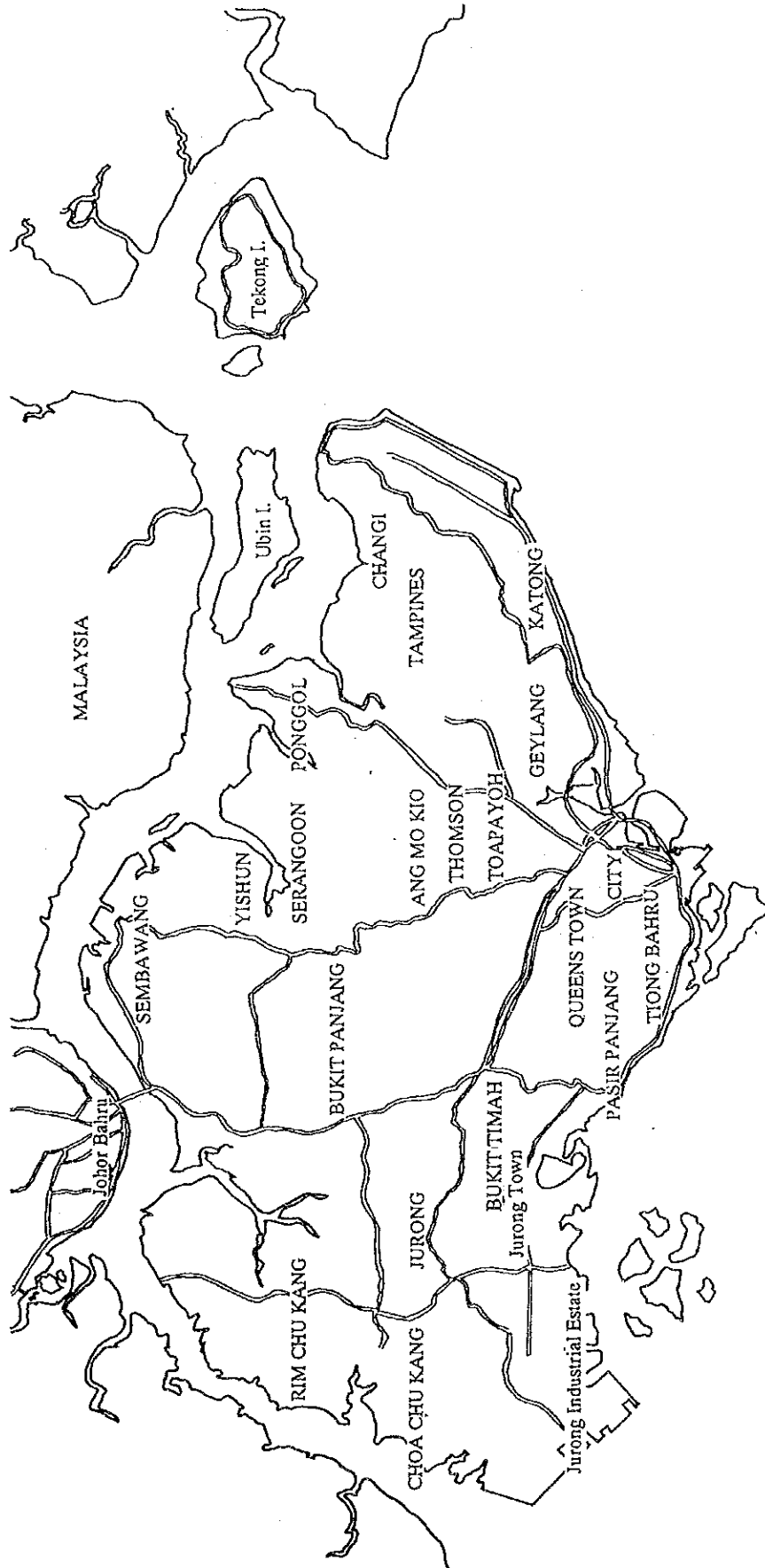
Very truly yours,

A handwritten signature in black ink, appearing to read 'Tetsuo Inooka', written in a cursive style.

Tetsuo Inooka

Team Leader, Study on
Development of Packaging Center
in the Republic of Singapore

SINGAPORE



Abbreviations

AAC	Automation Applications Center
ASEAN	Association of South East Asian Nations
ASTM	American Society for Testing and Materials
BIB	Bag in Box
CAD	Computer-Aided Design
CD	Compact Disc
CIM	Computer-integrated Manufacturing
CPP	Cast Polypropylene Film
CPPC	Corrugated Paper and Paperboard Cartons
CRT	Cathode Ray Tube
DBS	Development Bank of Singapore
DI Can	Draw and Ironing Can
DRD Can	Draw and Redraw Can
EC	European Community
EDB	Economic Development Board, Singapore
EO	Easy Open
EPC	Enterprise Promotion Centers Pte. Ltd.
EPE	Expandable Polyethylene
EPS	Expandable Polystyrene
EVOH	Ethylene Vinyl Alcohol
FFS	Form Fill Seal
GMP	Good Manufacturing Practice
GSP	General System of Preferences
HDPE	High Density Polyethylene
HIPS	High Impact Polystyrene
IATA	International Air Transport Association
IBC	International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk
IC	Integrated Circuit
ICAO	International Civil Aviation Organization
IEC	International Electrotechnical Commission
ILAC	International Laboratory Accreditation Conference
IMDG	International Maritime Dangerous Goods
IMO	International Maritime Organization
INTRACO	Intraco Ltd.
IPO	International Procurement Office
ISDN	Integrated Services Digital Network
ISO	International Organization for Standardization
ITB	Industrial Training Bureau
ITC	Industrial Technology Certificate
ITF	Interleaved Two of Five
J/V	Joint Venture
JAN	Japanese Article Number
JICST	Japan Information Center for Science and Technology
JIS	Japanese Industrial Standards
JTC	Jurong Town Corporation
LL	Long Life
LNE	Laboratoire National d'Essais, France
LSI	Large Scale Integration
MA/CA	Modified Atmosphere/Control Atmosphere

MARPOL	International Convention for the Prevention of Pollution from Ships
MAS	Monetary Authority of Singapore
MIL	Military Specifications and Standards, USA
MNC	Multinational Company
NC	Numeric Control
NCB	National Computer Board
NIES	Newly Industrialized Economics
NPB	National Productivity Board
NSTB	National Science and Technology Board
OA	Office Automation
OECD	Organization for Economic Cooperation and Development
OEM	Original Equipment Manufacturing
OHQ	Overseas Headquarters
OPP	Oriented Polypropylene Film
OTC	Over the Counter
PA	Polyamide
PB	Private Brand
PCB	Printed Circuit Board
PCS	Packaging Council of Singapore
PCs	Personal Computers
PE	Polyethylene
PET	Polyethylene Terephthalate
PI	The Packaging Institute, USA
POS	Point of Sales System
PP	Polypropylene
PPM	Parts Per Million
PSP	Foamed Polystyrene Paper
PU	Polyurethane
PUB	Public Utility Board
PUF	Polyurethane Foam
PVDC	Polyvinylidene Chloride
R.H.	Relative Humidity
SDF	Skills Development Fund
SINGLAS	Singapore Laboratory Accreditation Scheme
SISIR	Singapore Institute of Standards and Research
SMA	Singapore Manufacturers' Association
SMEs	Small and Medium Enterprises
SOLAS	International Convention for the Safety of Life at Sea
SS	Singapore Standards
TAPPI	Technical Association of the Pulp and Paper Industry
TDB	Trade Development Board, Singapore
TFS	Tin Free Steel
TQC	Total Quality Control
TV	Television
UN	The United Nations
UNIDO	The United Nations Industrial Development Organization
UPC	Universal Product Code
VCR	Video Cassette Recorder
VITB	Vocational & Industrial Training Board
VTR	Videotape Recorder

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1 Background, Objectives and Scope of the Study

1.1 Background and Objectives of the Study

From its historical position of entrepot trade center, Singapore has grown into a total business center providing comprehensive service functions for production, physical distribution and financial activities. The main factors supporting this evolution have been, 1) the manufacturing industries, 2) the commercial, transportation and communication industries, and 3) the financial and service industries. The packaging sector (packaging industry and packaging sections of manufacturing and physical distribution industries) is expected to support the development of the manufacturing industries in the fields of production and distribution.

The annual scale of output of the packaging industry of Singapore amounts to around 80 billion yen (representing about 28% of the national GDP). 28% of sales is exported while 72% is for domestic markets. The main domestic user industries are the food, electrical and electronic, chemical and pharmaceutical industries, all of which are largely orientated to export markets. Therefore most of the packaging products manufactured in Singapore are exported whether it be directly or indirectly, and the packaging industry forms an important factor in Singapore's competitive power in the export markets. As a result, the packaging sector is expected to carry out continued efforts for its technical development to be able to meet the changing market needs of the user industries.

However the majority of firms in the packaging industry with the exception of a small number of foreign affiliates are small to medium size firms and do not possess in house facilities or functions for carrying out technical development. Equally in the case of the packaging related sections of the packaging users, even in the case of the foreign affiliates, the technology for packaging design and packaging management is often insufficient as a result of reliance on the packaging services of parent companies. The packaging sector in Singapore does not therefore fulfill its role as supporting industry promoting the industrial development of Singapore.

In order to nurture and promote the domestic packaging sector the government of Singapore established the Packaging Center within the SISIR (Singapore Institute of Standards and Industrial Research). In this context, the government of Singapore has requested the Japanese government to undertake the study on development of the Center including development and operation plan, staff training plan, and facility and equipment plan. In response to the request, the JICA (Japan International Cooperation Agency) sent the Preparatory Study Team to Singapore in June, 1992, and signed the Scope of Work

(S/W) in agreement with SISIR for the Government of Singapore for implementation of the study. JICA dispatched the Study Team, based on the S/W, composed of members from UNICO International Corporation and the Japan Packaging Institute. This Report presents the outcome of the study thus carried out by the Study Team.

1.2 Scope of the Study

The Scope of Work for the Study defined in the S/W agreed and signed on June 24, 1993, between the Preparatory Study Team and the Government of Singapore is as follows:

- 1) Macroeconomic overview
 - a) Basic indicators
 - b) Sector-wise economic trends
 - c) Employment structure and income distribution
- 2) Confirmation of policy background
 - a) National and sectorial economic development policies
 - b) Specific policies relating to packaging industries
 - c) Policies governing SISIR and the Packaging Center in particular
- 3) Assessment of local packaging industries
 - a) Production technologies
 - b) Production facilities and equipment
 - c) Scale of production
 - d) Business type and operational structure
- 4) Analysis of user industries' demand for packaging
 - a) Type and volume of products of major user industries
 - b) Proportion and level of in-house packaging
 - c) Requirement for technologies and design of packaging
- 5) Review of present status of "SISIR" in general and the Packaging Center in particular
 - a) Governing laws and regulations
 - b) Organization and personnel
 - c) Existing activities

- d) Budget and financial situations
 - e) Contemplated plans for development
-
- 6) Formulation of the development plan of the Packaging center in "SISIR"
 - a) Organizational set-up and required personnel
 - b) Proposed functions and activities
 - c) Estimation of revenue and expenses
 - d) Required facilities and equipment
 - e) Staff training program
 - f) Required local investment and foreign inputs
 - g) Economic and social impact
-
- 7) Conclusion and recommendations
 - a) Ways and means for realization of the development plan
 - b) Policy guidelines for the development of packaging industries in Singapore

Further, during the study, samples of Singapore packaging products were tested to identify and clarify technical problems, and to this end the Study Team made use of an array of testing equipment. The equipment was used by the Team at the same time, to the transfer of package testing technology. Further, the Team, through seminars during their stay, provided to the related industries with Japanese expertise and know how concerning packaging technology.

2. Industrial Development in Singapore

This chapter presents an overview of the social and economic conditions in Singapore, and analyze the economic status of Singapore in relation to adjoining countries (2.1). Further, the progress in industrial development and direction of current development policies will be studied to clarify on a macro basis of the role a Packaging Center to play (2.2, 2.3).

2.1 General Situation of Singapore Economy

2.1.1 General

Singapore, a city-state with an area of more than 600 square kilometers, endowed with an excellent natural harbor and enjoyed favorable location for the international transportation, has flourished as an entrepot since the days of the British colony. Following achievement of independence from Malaysia in 1965, in tandem with the economic development of the adjacent countries, Singapore has demonstrated an amazing development record, by adding to the earlier financial center functions the functions of a distribution center for regional trade, as well as a production center for multinational corporations and, thus recognized as one of the Asian NIEs.

Singapore consists of the main island at the southern tip of the Malay Peninsula and more than 50 small islands. About a half of the national area is occupied by housing, commercial and industrial sites. Not even 2% is used for agriculture.

The population is 2,760,000 (estimate as of mid of 1991), of which 77.7% are ethnic Chinese, 14.1% are ethnic Malays, and 7.1% are ethnic Indians. Official languages are English, Malay, Chinese and Tamil, but most business is conducted in English.

Social and economic indicators of Singapore are shown in Table 2-1 in comparison with the other NIEs and ASEAN countries.

2.1.2 Overview of the Economy

2.1.2.1 Economic Growth and Industrial Structure

The annual growth rate of the GDP of Singapore was 8.4% on the average for the whole period of 1960 through 1990 as shown in Table 2-2. In 1980s, however, it has experienced a negative growth rate in both 1985 and 1986. This decline in performance is attributed primarily to stagnation (the silicon cycle) in the electronics industry, which has been the leading sector in Singapore economy, and no other industry could lead the industry in replace of the electronics industry.

Further, since 1988, when the economy achieved double-digit growth of 11.2% for the GDP, the growth rate has tended to decline since then, to 9.2% in 1989, 8.3% in 1990 and 6.7% in 1991. It is estimated that growth in 1992 was about 5%. The main cause of the stagnated growth of the economy can be attributed mainly to the slump in the financial and services sector, and manufacturing sector, which have close connections with the change in the world economy. Regarding the exogenous factors, which exerted influences on the Singapore economy, the Gulf War, the slower growth of the world economy, and particularly the stagnation of US economy were the major ones. The Singapore economy has become sensitive to the world economy.

In the GDP of Singapore the manufacturing sector's importance is high; it has a share of 28.6%, that is followed by financial and services with 27.4% (1991 provisional; Table 2-2). In 1960, when the economic base of Singapore was dependent on its entrepot status, commerce had a 24.6% share, but this has been eclipsed by manufacturing since 1970. Thereafter, in 1980, finance and services came to be more important than commerce, and in recent years became close to the manufacturing. It is the reflection of the fact that the economy of Singapore, after having been based on entrepot status, through the development of the manufacturing sector, and then after a switch from labor-intensive to capital-intensive manufacturing, has progressed even further to becoming a services-exporting economy that makes great use of the finance, business services, and telecommunications).

The contributions of each industrial sector to GDP growth of Singapore is shown in Table 2-3. The contribution from manufacturing was the greatest as of 1988, but in 1989 that of the finance and services sector was the largest.

Employment has risen on the strength of the strong economy, and the unemployment rate was 1.9% in 1991, showing that a condition of nearly full employment exists. The unemployment rate had been 4.9% in 1960, and 6.0% in 1970, but creation of more jobs resulted in a decrease to 3% in 1980, and the rate has been less than 2% since 1990 (Table 2-4). Because of this recent situation, a shortage of manpower for industry has been chronic, and it has become difficult to obtain the needed number of workers particularly in the shipbuilding, construction, hotel, food and other industries. Further, job hopping has become common, and turnover in the blue collar jobs rose to 13-16% in 1990. The combination of a shortage of workers and corporate competition for human resources has driven wages up; wages rose by about 9% in both 1990 and 1991. In manufacturing in particular, when wages rose 11% in 1991 it marked the fourth year for double-digit increases. The wage inflation combined with appreciation of the Singapore dollar has exerted adverse influence on the competitiveness of the country's manufacturing sector.

Prices have been stable. Consumer price inflation has been less than 4% since 1982 (averaging 1.6% during 1982-1991). The price index for transportation and communication rose 4.5% in 1989, 7.8% in 1990 and 7.0% in 1991, which are rates higher than those for other sectors.

2.1.2.2 International Balance of Payments and Trade

Singapore international balance of payments has been in surplus for a long time. The current account balance and the capital account balance have both been in surplus. Within the current account balance, however, the trade balance (merchandise trade balance) shows a deficit that has been more than offset by a surplus (net inflow) in balance of services. The transfers account, on the other hand, has shown small-margin deficits.

The most important source of the surplus on the balance of services account is the net income for commissions, royalties, etc. This surplus is seen as being derived from the financial and services sector, and accounts for about 80% of the surplus on the service export account (as of 1990).

Among merchandise exports, machinery and transport equipment account for the largest share, 51% (in 1991), followed by oil and oil products with 17%. In the past Singapore most typical export was rubber, that was 41% of exports in 1960. Expansion of petroleum refining capacity and progress in industrialization in 1970s resulted in increase in exportation of oil and oil products, and machinery and transport equipment. In particular, the share of oil products was high up to the early 1980s, and was 29% in 1980, whereas that of machinery and transport equipment were 27% and rubber 8%. In 1983, however, the share of machinery and transport equipment in exports came to surpass that of oil products (Table 2-5).

In the case of other NIEs as Korea, Taiwan, they first been primarily exporters of light manufactures such as textiles before machinery became their major category of exports. Singapore is characterized by not having gone through such a step and has long had a concentration of machinery, and especially electronic and electric equipment, in its exports. "Machinery" includes ships as well as general industrial machinery. The share of oil products in exports has been declining, but increases are evident in plastics and chemical product exports, that are based on oil products made in Singapore. That is, Singapore exports have been rapidly moving toward products of higher levels of processing and manufacturing.

There have been changes in exported items by market. For the European nations and United States, where raw materials had been most prominent, there have been increases in

exports of machinery and industrial products other than machinery since the 1970s. Exports to Japan and NIEs used to be concentrated in oil and oil products but the share of machinery has been increasing. Regarding ASEAN, the major export market for Singapore, industrial manufactures used to be the major export item, but this was replaced by oil products in the 1970s and by machinery in the 1980s.

Great change has taken place also in imported items. In the case of European countries and the United States there has been no significant change for long period with major import items from these countries being machinery and other industrial products. In the case of Japan and the NIEs, in contrast to that, there has been a sharp change from importation of industrial products to importation of machinery. Whereas ASEAN used to be a source of raw materials for Singapore, in the 1970s oil was added to these items. Thereafter, in the latter half of the 1980s, there have been increases in import of machinery and industrial products.

The above trend is the reflection of the facts that (1) the industrialized countries such as Japan has transferred their production basis from NIEs to ASEAN concentrating domestic industries to the more sophisticated ones only, (2) development of industrialization is significant in ASEAN countries, and (3) the advancement of industries in Singapore is progressing.

In Singapore, the role of re-exports, in addition to that of domestic exports (exports of domestically-made goods), has been important. Previously, in about 1960, reflecting Singapore position as an entrepot, re-exports occupied a share of more than 90%. In keeping with subsequent progress in Singapore industrialization, however, the share of domestic exports rose and by the mid-1970s exceeded re-exports. At present (in 1990), re-exports have a share of 34% (Table 2-6).

Changes have also been evident in destinations of exports. In the case of domestic exports, the exports to the United States and Europe are increasing (comparing 1970 and 1975, from 15.1% to 18.6% for West Europe, and 11.8% to 16.3% for North America), whereas the share has declined from 38.1% to 14.6% for ASEAN. In the case of re-export, while it has risen in trade with ASEAN, they have been cut to half in trade with West Europe. This trend is the reflection of the following change in Singapore position. Namely, Singapore industry used to be a production base supplying the ASEAN countries. However, In response to advance of industrialization in ASEAN countries, and shift of Japanese production base for US and European markets to ASEAN and Singapore, Singapore has moved their industry to more sophisticated ones (1) as a distribution center for machinery parts and (2) as a production base supplying sophisticated machinery to the United States and Europe.

By country, in the case of exports to the US, disk drives are the single biggest item. Exports of chemicals are also high. Exports of appliances too are high but in recent years appliance assembly lines have been shifted to lower-wage countries so that exports of those products have tended to decline.

Regarding the EC, computers, peripherals and consumer electronics are the major export items. Growth of these items' exports has been greater than their growth as exports to the United States largely because of the expansion of market due to liberalization of East European countries, and the unification of Germany. Growth of re-export to EC has been high especially for appliances and computer parts.

Exports to Malaysia primarily constitute oil products, ICs, videos, cassette recorders, picture tubes, computers and peripherals. Among them, exports of ICs and certain appliances have shown a tendency to decline in keeping with increases in Malaysian production capacity.

About one-third of the exports to Japan are made up of aviation turbine oil, naphtha and other oil products. In 1991, in keeping with a decline in oil prices and an increase in domestic supply capacity in Japan, exports of oil products to Japan fell in one year by 22.0%. Exports other than of oil products are largely ICs, disk drives, computers, printers and telecommunications equipment. On the other hand, Japan is the major source of Singapore's imports, by supplying, in particular, telecommunications equipment, electrical machinery, machinery and other types of products.

2.1.2.3 Investment

Direct investment from abroad has played an extremely important role in the industrialization of Singapore. Domestic capital in Singapore was at first mostly commercial capital, owing to the nation's being an entrepot, and lacking experience in manufacturing as well as specialized skills. Even if there had been an interest in acquiring the experience and skills from abroad, the scale of the domestic market was too small to support such an effort. Therefore, in order to acquire the capital, the technology, and the access to markets, Singapore embarked on a vigorous program of inducing foreign investment.

From the 1960s to the early 1970s, making use of the competitive wage levels, Singapore induced foreign investment in labor-intensive industries. Besides the domestic economic conditions that the high level of economic growth attained at this time resulted in the tight labor market while no significant rise in labor productivity was attained, the conditions outside of Singapore also worked against attracting investment to Singapore. That is, 1) to an extent there was improvement of the infrastructure in adjacent low-wage

countries, that served to make those countries attractive to investors seeking low labor costs, and 2) it became difficult to expect that Singapore would continue to have the benefit of GSP treatment. Consequently, policy since the 1980s has favored development and attraction of sophisticated technology and high-value-added industry, involving a more selective process regarding welcoming foreign investment.

The tendency over the long term has been for capital investment from abroad to increase at a high rate. It was S\$10,140 millions in 1979 but quadruple that at S\$47,030 millions in 1989. Investment categorized by industry shows high levels for manufacturing as well as finance and services; respectively, S\$19,840 million and S\$19,180 million (both in 1989).

Total investment including that by domestic corporations, by manufacturing sector (commitment base) in 1990 is for S\$1,090 millions for the electronic products and parts sector, in first place, followed by S\$380 millions for the second-place petroleum sector. About 90% of the total is foreign capital, and the concentration of foreign investment is higher in key industries as compared to others. Taken in terms of foreign ownership of stock, for manufacturing overall it is 56%, while it is 95% in oil, 90% in electronics, and 83% in paint, chemicals and pharmaceuticals (according to the 1987 Report on the Census of Industrial Production).

Investment disaggregated by country shows the United States first with S\$9,150 millions, followed by Japan, S\$8,600 millions, while the EC as a group had S\$10,110 millions. These three combined had about 60% of the total.

The domestic investment consists of the government investment and private investment, and the relative importance of state corporations is very high in Singapore. Government investment has been concentrated in areas where the risk is so high as to discourage investment by ordinary industrial interests. Domestic capital investment, having been based on earlier commercial orientation, has not been readily committed to manufacturing, but recently Singapore corporations have become active in overseas investment including investment in China.

2.1.2.4 Economic Infrastructure

(1) Transportation and Communications

Port and harbor, airport, electric power and other aspects of infrastructure are at the high levels by world standards, and there are excellent services available in the areas of international telecommunications, finance and business. The volumes of marine cargo and air cargo handled here, at 188 million tons and 624,000 tons respectively in 1990, are the highest in the world. The diffusion rate of telephones is high, at one per 2.26 persons in 1987, and the number of portable telephones too is high. Through use of

satellites as well as underwater cables, the number of international telephone calls placed in 1990 was about 74 million. ISDN service began in 1989.

(2) Utilities Supply

The supply of power, gas and water is performed by the PUB. All energy sources are imported, but there is no problem with regard to supply. Singapore is served by four power stations that have a total capacity of 3,627 MW. Gas, from a naphtha conversion plant is supplied at 854,000 cubic meters a day.

(3) Industrial Estates

Jurong Town Corporation (JTC) manages a large number of industrial estates, that are separated into littoral heavy-industry, light-industry, food and pharmaceuticals, warehousing, and urban-industry type uses. Sites are leased to users who put up their own buildings, but in some cases buildings are leased from JTC. In Batam, the island 20 km from Singapore, there is an industrial estate that is attracting companies from Singapore proper because of lower wages at the former.

2.1.2.5 Technical Infrastructure

(1) School Education

Concerning the educational level of Singapore workers, the percentage who have received middle and higher-level education is low relative to that of both industrially advanced nations and Asian NIEs. For that reason the Singapore government has assigned high importance to education and devotes one-fifth of its budget for that. In quantitative terms, there have been great advances made over the past decade. In particular, as a national policy for elevation of industrial education, emphasis has been placed on development of engineers and scientists. The course of education encompasses six years of grade school, four years of middle school, two years of junior college or three years of college. National examinations are required for promotion in and to grade and middle school, and those who failed the examination for three years, have to shift to vocational education courses. School education is provided in two or more of the four official languages (English, Chinese, Malay, Tamil).

(2) Technical Education

High-level technical education is provided at the National University of Singapore, Nanyang Technological Institute, Singapore Polytechnic, Ngee Ann Polytechnic, Temasek Polytechnic and other schools, in addition to which the Vocational and Industrial Training Bureau (VITB) operates 15 schools. Those who have completed the

skilled workers training course are qualified to receive certificates such as the Industrial Technology Certificate (ITC), national certificates, etc. Moreover, for development of human resources, the Economic Development Board (EDB), on the basis of bilateral agreements and with the cooperation of MNCs, has opened skilled worker training centers and schools of various kinds. The government also provides subsidies through its Skill Development Fund for companies seeking to improve the technical qualities of their employees.

(3) Technological Guidance System

SISIR provides certification systems (SISIR Certification Mark Scheme and SISIR ISO Certification Scheme), transfer of technology, technological guidance, collection of technical information, technical training and specialized consulting services. The Ngee Ann Polytechnic and Singapore Polytechnic are providing technical guidance for industry.

(4) Support for Research and Development

Objectives of government policy regarding R&D are 1) improvement of product design and development capabilities, and 2) development of technology related to financial activities. The government assigns high importance to R&D undertaken by the private sector, and has adopted a preferential tax scheme to promote it, in addition to providing funds to public and private institutions engaged in R&D. As for human resources related to R&D work, in addition to seeking to increase the number of persons who have done post-graduate work, the government has adopted the objective of improving creativity-developing aspects of school education. In the area of technology, there are arrangements whereby SISIR and the Polytechnics execute research for private industry or collaborate with private industry for R&D, and their facilities and personnel are available for private firms to use.

2.2 Industrial Development in Singapore

In the latter half of the 1950s, prior to its independence, industry in Singapore had only the aspects of 1) primary processing and trading of rubber and tin, 2) foodstuffs industry for the domestic market, and 3) entrepot trade.

In 1961 the Economic Development Board was created and Singapore embarked on a program to replace dependency on entrepot trade with a modern economic structure.

At this time policy emphasis was on import substitution, i.e., the industrialization targeting domestic market. There were, however, the inherent restrictions presented by the small scale of that market.

In 1967, the government sought to overcome these limitations by fostering export-oriented industry. That is, export-led industrialization, by means of mobilization of foreign capital. This meant that in place of the domestic companies, that lacked international competitiveness, foreign corporations, possessing the technology and market access were to be central in the industrialization process. This policy has continued in effect to this day.

Initially, export-oriented industrialization was based on labor-intensive industry, as Singapore possessed an ample supply of labor. But starting in the 1970s a shortage of labor emerged, and wages rose faster than productivity. Then, when the oil crisis of 1973 raised the costs of imported goods, the export industry, that had been reliant on imported inputs, received a powerful blow. The government sought to cope with that by restraining wage increases and fostering improvement of productivity.

In 1979 the government recognized the limitations of further pursuit of a labor-intensive industrialization policy and changed to favoring a capital- and technology-intensive approach. This policy shift is symbolized by high wages and salaries, production of goods high in value added, use of higher levels of technology, and information industry.

2.2.1 Industrial Development Prior to 1985

As stated in the above, in the latter half of the 1950s, prior to its independence, industry in Singapore had only the aspects of 1) primary processing and trading of rubber and tin, 2) foodstuffs industry for the domestic market, and 3) entrepot trade. The prevailing unemployment and shortage of housing supply was the serious problems in the socio-economic areas.

A report prepared by UNIDO in 1960, on the basis of economic unification with the Malaysian Federation, recommended construction of industry for import substitution. In the report it was indicated that local interests lacked industrial know-how and was primarily of the nature of commercial capital, so that attraction of foreign investment on a large scale was necessary. Further, as the recommended role of the government, it called for 1) improving the management of the workforce and level of its wages, 2) creation of industrial estates, 3) improvement of technical training, 4) adoption of preferential taxation, and 5) liberalization of capital transfers. This manner of thinking was incorporated in the National Economic Development Plan (1961-1964), announced in 1961.

With the establishment of the EDB in 1961, efforts were made to change from reliance on being an entrepot to having a diversified, modern economy.

Industrialization during this period was based on import substitution to satisfy domestic demand. At that time, in addition to utilizing foreign investment, importance was given to mobilizing domestic capital. The government was not inclined to directly intervening in economic affairs, but took the stance of fundamentally promoting the change and limited its own initiative to housing, education and other areas of social policy.

There was, nevertheless, the given restriction of the small scale of the domestic market in the industrialization through import substitution. There also was some social and political instability, that served to limit effects at attracting foreign as well as domestic investment.

In 1965, Singapore became independent from Malaysia. This made it necessary to abandon the concept of import substitution based on Malayan common market. Further, deterioration of relations with Indonesia resulted in a decrease in entrepot trade, and closure of the British military base contributed to a reduction in domestic demand, creating an urgent need for Singapore to rebuild its economic base.

The the government sought to accomplish this rebuilding by putting the economy on an export-oriented industrialization. That is, by supplementing domestic interests, that did not by themselves have international competitiveness, with export-oriented industry relying on foreign investment, a change was made to industrialization based on foreign corporations possessing both technology and export markets. At the same time, the government actively intervened in the industrialization process. That is, rather than emphasize macroeconomic policy as a means of stabilizing the economy, and general industrialization policies such as creation of infrastructure and provision of support through financial and tax measures, the government became involved in activities such as control of real estate and labor markets, development and allocation of human resources, through public corporations.

The government had actively participated in these public corporations. The Economic Development Board was the central entity in this process, and in the area of economic activities, the board transferred functions to the JTC, DBS, INTRACO and other bodies. Technological support functions were transferred to SISIR, NPC and ITB, set up by the EDB. In the manufacturing sector the government had set up 38 companies by 1972, that came to contribute 14.8% of value added and provide 13.0% of employment in that sector.

Industrialization during this period (1966-73) reflected the increase in international expansion by companies of the major industrial powers, and investment was largely made by those companies and the public corporations (especially through joint ventures), whereas investment by domestic interests was stagnant. The share of industrial

employment accounted for by fully-foreign owned corporations during 1966-1972 rose from 12% to 29%, and in terms of share of value added, these corporations recorded an increase from 26% to 43%, as well as an increase from 40% of capital output by manufacturing to 63%.

Export-oriented industrialization during this period was led by petroleum refining and chemicals, sectors that could benefit from Singapore's geographical advantage, and labor-intensive industries such as electronics and electric equipment, and apparel, that were based on an abundant supply of labor. During the 1970s, however, the shortage of labor became serious, and wages rose more than did productivity. When imported inputs rose in price as a result of the oil crisis of 1973, it imparted a powerful impact to the export-oriented industrialization process. The government sought to restrain the increase in wages, and to promote productivity gains. The government, moreover, recognizing the limitations inherent in labor-intensive industrialization, changed to a policy of promoting capital- and technology-intensive industrialization. This policy change is symbolized by the orientation to the industries of higher wages, higher value added products, higher technologies, and information based, and was accomplished by achieving stronger ties with the MNCs that possessed advanced production and managerial capabilities, technology, and market access. This process, however, had to wait to be implemented, until, after the end of the first wave of attraction of investment to Singapore ended in 1973, until the second wave arrived five years later. Therefore, during this period, it became more important to rely on a low-wage, labor-intensive policy. As one result, the level of unemployment declined and it became unavoidable to depend on bringing foreign workers in.

In 1979 the government adopted a policy for upgrading of industrial structure to higher industry oriented one. In the background for this was a factor to constraint on wage growth for Singaporean workers owing to the influx of foreign workers, resulting in discouraging their will to improve their skill level, while management was also discouraged their motivation to make improvements for higher industries. This represented a crisis as the ability for industry to grow further was now limited by Singapore's having reached the maximum level of labor supply capacity it could have. The policy for high-structural industry of Singapore's industry gave emphasis to productivity improvement on the part of management, promotion of transfer of the low-level-technology and labor-intensive sectors to adjacent countries, raising of wages, and at the same time an increase in efforts by the government to improve the skills of the workforce.

2.2.2 The Recession of 1985, and Changeover In the Industrial Development Policy

In 1985, however, the economy (in terms of the gross domestic product) contracted by -1.6% in real terms, making it necessary for the government to re-evaluate its industrial policy. An Economic Committee set up to examine the cause of the recession and analyzed the causes separating them into the following foreign and domestic factors.

Foreign Factors

- 1) Stagnation of the petroleum refining sector and the shipbuilding and repair sector, as a consequence of the worldwide decline in oil demand
- 2) Decline in demand for services from adjacent countries, owing to softening of commodity markets
- 3) Weaker export demand because of the soft American economy resulting in weaker demand for electronic parts and computer-related equipment

Domestic Factors

- 1) Increases in rents and wages undermined export competitiveness and served as constraints to investment on manufacturing
- 2) Weakness in the construction sector due to oversupply in the real estate market
- 3) Lack of sufficient domestic demand, while excessive expansion of savings
- 4) Rigidities in the economy

It was thought that these domestic factors were consequences of excesses in intervention in the economy by the government during the first half of the 1980s, through such means as control of wages and factor prices, and control of savings, and of rigidities in systems whereby the economy was managed. A shift to a greater role for the private sector was advocated on this basis.

The analysis of the factors behind this recession in 1985 are of great importance when considering the path Singapore's industrialization will take from this point onward. The major points are as follows.

The first is a declining trend of output of manufacturing sector. It would appear that the decline in the economic growth of total economy in 1985 was a sudden event, but if the growth rate of individual sectors is examined it becomes evident that manufacturing already started to decline at the start of the 1980s. What offset this was the prosperous

condition in construction sector that resulted from the government's efforts to stimulate demand.

The investment in manufacturing had been declined starting in 1982.

The second factor is weakness of the impact of indigenous investment on economic activation. More to the point, Singapore's economy was much dependent on foreign capital, that made it much more difficult to avoid adverse effects of a downturn in the world economy. According to a study¹⁾ the impact of indigenous investment was merely one-fortieth of that of foreign investment.

The third is the fact that the policies favoring high wages and high value added, during the 1980s, raised operating costs, while the domestic sector was for the most part unable to attain the high value added targets.

The fourth is excessive investment on infrastructure, in particular to housing, which was created as a result of the promotion of high savings and turned out to be excessive, resulting in oversupply and idle resources.

The Committee advocated the following medium-term goals in order to achieve a business environment that was superior to that of the OECD countries, and a higher rate of profit, while turning Singapore into an international business center and increasing her exports of services. The strategy was:

- 1) Maintenance of a high savings rate
- 2) Formation of an environment conducive to profitable business activities
- 3) Greater reliance on the private sector
- 4) Promotion of offshore economic activities
- 5) Development of both MNCs and local industries

What is characteristic here is the shift in viewpoint from the traditional industrialization based on attraction of foreign capital to need for higher importance for domestic industry.

Further, these are characterized, from the viewpoint of industrialization, as viewing service sector and not manufacturing sector as the leading sector during the coming decade. This is a strategy that reflects the rapid economic growth of the adjoining countries on one hand, and limitations to increase in Singapore's ability to increase the supply of manpower and infrastructure.

In the services sector, apart from the existing marine transport, air transport and telecommunications subsectors, there are expectations for foreign investment in business

¹⁾ Toshiaki Hayashi, "Industrialization in Singapore --Business Center of Asia--", (Institute of Development Economics, Tokyo: 1990) (Japanese Version)

and professional services, publishing, computer services, testing services, and educational and training services.

In comparison to this, a decline is expected for investment in manufacturing other than in electronics, telecommunication equipments and information technology, bio-industry, pharmaceuticals and optics, and efforts must be devoted to inducing subsectors having high profit potential, and promoting establishment of regional headquarters in Singapore by MNCs in addition of regional production base of MNCs.

The new industrialization and economic policy based on these considerations is embodied in the Strategic Economic Plan, that was released in 1986, and which is the basis for industrialization policy being implemented today.

2.3 The Production and Distribution Structure of Singapore's Industrial Sectors and Direction for Industrial Development

2.3.1 Outline

Table 2-9 shows major managerial indicators by industrial sub-sector. In terms of output the electronics sector is the largest industrial sector accounting for 39% of total industrial output followed by the oil products sector which accounts for 16% of the total. It is evident from the fact that the combined output of these two sectors accounts for 55% of the total that industrial development in Singapore has been concentrated in certain particular sub-sectors.

The industrial sub-sectors of Singapore can be classified to some sub-sectors according to the export ratios, ratio of foreign investment, degree of labour intensity, output per firm, etc.

As a result of the small size of the domestic market the industrial sectors of Singapore are generally export orientated. 66% of the gross sales of the total industrial sector is exported. Of this, the largest export ratio is for instrumentation equipment (with exports accounting for 94% of sales), followed by electronic products (85%), and the chemical and pharmaceutical sectors (79%). All of the above three sectors show a large ratio of paid up capital from overseas investors of 80%, 83% and 90% respectively. Nevertheless the structure and nature of production differs between that in the case of instrumentation equipment and electronic products to that found in the case of the chemical and pharmaceutical sectors. The former are generally manufacturing industries with a value

added per employee almost equivalent to the average of total manufacturing sector and a lower than average figure for capital assets per regular employee. This means that such industries tend intrinsically to rely heavily on cheap wage labour. In contrast both the value added and capital assets per regular employee in the chemical and pharmaceutical industries tend to be high and so industries aiming to make use of Singapore's geographical and transport advantages are attracted.

Another sector with a high export rate is the textile and apparel industry. While the export rate is very high at 83% the share of foreign capital is only 23%. Also the figures for value added and amount of capital asset per regular employee are both low. The output of single firms is also small. The industry is based on local capital and depends for its competing power on the existence of cheap labour.

Industries with export rates and overseas investments on a par with the averages for these among manufacturing industries include the industrial chemicals and gases, non electrical machinery, electrical machinery and food sectors. In these sectors the products for domestic market has the relative importance, as the raw materials and parts for domestic production, or as the final products in the case of food. There is a mixture of companies whose capital is funded locally with companies which are based on capital investments from overseas. However, generally speaking there is a considerable difference in the markets targeted and the products manufactured by the locally funded companies on the one hand and the companies funded by foreign capital on the other.

The oil and oil product sectors have a similar level of export rate to the above sectors but in contrast to these the share of overseas capital is large. However since direct export of output is low in the oil and oil product sectors, the output largely serves as raw material for a wide range of domestic industrial production, and so export is of an indirect nature. This sector is the most capital intensive sub-sector among the manufacturing industries.

In general sub-sectors with low export rates also have a low foreign equity. These include printing, publishing, plastics, paper manufacture, and beverage industries. With the exception of the beverage industries the level of capital equipment ratio is low, and these sectors are mostly concerned to satisfy domestic demand. Many of the packaging manufacturers come under this category. The main market for beverages is also the domestic market but since automation processing must be imported for manufacturing processes the level of capital equipment ratio is somewhat high compared to the other industries of this category.

The metal working industry has a slightly high level of foreign equity with a low export rate. Actually the firms based on overseas capital investment and those which are locally funded show different characteristics. The former carry out exports to other

foreign affiliate companies based locally in Singapore or to surrounding countries and these firms possess a relatively high technical level. The latter firms are metal working companies serving domestic local industries.

2.3.2 Industrial Development and SMEs

2.3.2.1 SMEs in the manufacturing sector

For the purposes of its various measures and policies concerning SMEs, the EDB defines SMEs in the manufacturing sector as those firms with at least 30% local equity and not more than S\$8 million in net fixed asset investment.

The Local SMEs constitute a large part of Singapore's economy. They account for about 90% of establishments, 44% of employment, 24% of the value added and 16% of direct exports in the manufacturing, commerce and service sectors taken together.

The SMEs in Singapore have not developed as a result of subcontracting relations with large industries along the lines seen in countries such as South Korea or Japan. Rather, the individual firms tend to carry out their activities independently of each other both domestically and on export markets.

The SME Master Plan²⁾ listed the following five sub-sectors where SMEs have achieved above-industry average performance.

1. Paints and pharmaceuticals
2. Transport equipment
3. Food and beverage
4. Supporting industry
5. Machinery

However, there are considerable differences between those SMEs which are local industries and those which are foreign affiliates (Table 2-10)³⁾. The foreign affiliate SMEs are on a small scale because of the limited size of the markets in Singapore and surrounding countries but such firms do not actually differ in nature from the large scale MNC. In contrast to this the local SMEs employ a workforce which is on average 40% smaller than that employed in a foreign affiliate firm, moreover the level of capital equipment ratio is low and labour productivity poor in the local SMEs. The value added and export rate of the local SMEs is around two thirds of the levels for these among the foreign affiliate SMEs.

²⁾ SME Committee, EDB, "SME Master Plan (Report on Enterprise Development)."

³⁾ The latest data available is those in 1990. However, since the definition of the SMEs in the latest data is different from that of EDB, this table used the data in 1973.

The past nurturing of SMEs carried out with giving preferential conditions to foreign investment was not necessarily successful. Many of the local SMEs have not yet reached levels of product quality and technical expertise which can be expected from the foreign affiliates and this explains the low level of domestic procurement by foreign affiliated firms (Table 2-11).

2.3.2.2 SME Master Plan

The government of Singapore is committed to promoting and developing the SMEs and has drawn up a Master Plan to support this sector of the economy. One of the major aims of the Master Plan is to reorganize the economic structure of Singapore.

Since one of the fundamental assumptions of the Master Plan is self help, the government has outlined measures of assistance over and above the traditional promotional measures accorded to SMEs, and these will be provided to those SMEs with latent potential for further development or for upgrading. The policy of Singapore is certainly not based on a desire just to protect the existing SMEs.

Rather, assistance is to be given to SMEs assure strong basic service industries and supporting industries which will permit cooperation with MNCs, resulting in establishing Singapore's position in the world economy.

The Master Plan pointed out the sub-sectors listed in Table 2-12 as the sub-sectors where SMEs have achieved above-industry average performance or possess good potential for growth.

2.3.3 Direction of Industrial Development

(1) Strategic Economic Plan

The Singapore government reassessed its industrial development policy in response to the recession. The Strategic Economic Plan⁴⁾ issued in 1991 shows the current direction of industrial development in this country. In that plan the following two concepts are particularly emphasized since they provide a useful frame of reference for the overall strengthening of the economy in a wide range of areas.

- 1) international competitiveness without a direct cost advantage
- 2) soft infrastructure (or, the elements of a country's economy and society, apart from resources and physical infrastructure, which make it dynamic).

⁴⁾ The Economic Planning Committee, Ministry of Trade and Industry, "The Strategic Economic Plan: Towards a Developed Nation", (1991)

These concepts clearly indicate the intended direction of industrial development of Singapore, which has faced the rapid industrial development of the adjacent countries on one hand, and encountered with limitations in the domestic market size and the supply ability of manpower.

The Strategic Economic Plan aims to achieve development on a selective basis rather than the comprehensive development aimed at in other countries. Moreover, this selective development will not be decided by the government itself but as a result of the realities of market forces and of the private sector's participation. On the other hand recognizing the existence in Singapore of certain sectors with poor productivity it is proposed that measures to eliminate or reduce factors obstructing improvements in these areas be carefully investigated.

It is also proposed that the selective development be determined not only by the individual subsectors but by the industrial clusters made up of subsectors in a given area of activities together with related commercial and service subsectors, and peripheral industries.

(2) Singapore and Industrial Development in Asia

The economy of Singapore has developed in very close relation with the world economy. Consequently when considering the future direction of industrial development to be taken in Singapore, it is important to give sufficient consideration to the changes in industrial structure among the advanced industrial nations and trends taking place in surrounding countries. Such changes have been particularly exerted influences on export position of Singapore.

The exports of Singapore are classified into domestic exports (exports of products manufactured in Singapore) and re-exports (of products imported from outside). Re-exportation has developed by making use of the natural geographical advantages of Singapore's position and as entrepot trade, but in recent years as a result of the provision of infrastructures such as transportation, communications, and commercial services which enhance this natural advantage. There are types of re-exportation which can be differentiated functionally. First, in the case of chemicals, foodstuffs, etc., a large quantity of single item product is received in Singapore where this is stored and modified (recombined, processed, etc.) to meet the needs of the end markets to which the modified products are then dispatched. In this case Singapore acts as an entrepot center. Secondly, in the electronic-electrical or transport machinery industries parts are collected from surrounding countries and Japan before being sent out to assembling factories in the countries around Singapore. In this case Singapore acts as an

international parts center. This second function is a refinement and upgrading of the intermediary entrepot role of Singapore, and in addition to the natural geographical advantage, and infrastructural superiority in terms of transport and communication provisions, it is important to undertake measures to ensure delivery control and quality control.

The largest export sector for the domestically produced items is for electronic and electrical products followed by food items. These two sectors differ considerably in nature. The electrical and electronic products are mostly manufactured by MNCs, which carry out concentrated production of products strategically assigned to Singapore as part of an overall world strategy. Output is then exported to target markets including those of the advanced industrial nations. Consequently the products produced must be up to international standards in quality and technical level. In contrast, although the target markets of food products are also dispersed worldwide, these are largely confined to the distribution channels serving overseas Chinese food outlets excepting China and South East Asian countries where the output is distributed via general food distribution channels. As a result, these products reflect very strongly the particular standards of a specific consumer group and so quality aspects differ from those applying in the case of international commodities.

Singapore's main industries and their supporting service sectors have developed in close relationship with the above export development.

As pointed out in the Strategic Economic Plan, in order to maintain the industrial development it is necessary to selectively support those sectors which can best make use of the advantages in technology, transportation, communication and financial services available so that these sectors enable to enhance Singapore's attractiveness over surrounding countries, while making optimum use of the capital, managerial, technical and marketing resources made available through foreign investments thus gained. It is also necessary to strengthen and support the development of the related supporting and service industries serving the sectors thus selected.

The packaging industry is one of the supporting industries which enhance the upgrading of manufacturing industry. Moreover, the packaging industry is the industry, which upgrading and strengthening is expected to lead to promoting a new service-export sector of its own.

Table 2-1 Economic Indicators in ASEAN and Asian NIEs Countries

	Unit	Singapore	Malaysia	Indonesia	Philippines	Thailand	Korea, Rep. of	Taiwan
1. Land Area (A)	sq. km	633	329,293	1,920,000	300,000	514,000	99,263	36,000
2. Population	million	2.76	18.17	187.76 (179.3)*1	62.87	56.92 (56.08)*1	43.27	20.36 *1
2) Population Density (B/A)	persons/sq. km	4,360	55	98	210	111	436	566
3. GDP	million US\$	(1991) 39,984	(1991)p 46,672	(1990)p 107,294	(1989) 44,342	(1990) 80,172	(1991)p 282,971	(1990) 161,755
3) Per Capita GDP (C/B)	US\$	14,457	2,569	598	738	1,430	6,540	7,945
3) Percent of GDP by Main Economic Sector:	%							
- Agriculture, Forestry and Fishery		0.3 *5	17.3	21.8	23.5	14.4 *6	8.1 *5	4.0
- Mining & Quarrying		0.2	9.4	14.5	1.7	2.9	27.9 *7	0.4
- Manufacturing		28.6	26.7	19.5	25.0	24.7		33.3
- Construction		6.1	3.8	5.5	4.4	5.2	64.0 *8	4.7
- Others		71.5	42.6	38.7	28.7	52.8		58.5
4. GNP	million US\$	40,899	44,810	102,514	44,246	79,346	280,939	161,700 *2
4) Per Capita GNP (D/B)	US\$	14,818	2,466	572	736	1,415	6,493	7,942
5. External Trade	million US\$	58,972	34,264	26,887	8,839 *4	23,115	71,879	67,214
- Exports	million US\$	66,100	35,023	21,455	12,052 *4	33,094	81,525	54,716
- Imports								
6. Exchange Rate (1991)	Nat'l Currency/US\$	1.7276	2.7501	1,950.3	27.479	25.517	733.35	26.815
				1,842.8	21.74	25.585		26.893
				(1990)	(1989)	(1990)		(1990)

Notes: p: Preliminary

*1: Mid-1990

*4: In 1991

*3: Ratio of GDP in 1985 Prices

*5: Ratio of GDP in 1985 Prices

*6: Ratio of GDP in 1972 Prices

Sources: UN Monthly Bulletin of Statistics

GDP, GNP, External Trade, Exchange Rate and *1: Institute of Developing Economies, Japan, "Asian Affairs, 1992"

*2: "Taiwan Source" (Taiwan Yearbook), 1991

Table 2-2 Gross Domestic Product by Industry, Singapore (1985 Market Prices)

Industry	GDP Value (Million S\$)										Change % vs. Preceding Year					Av. Annual Growth (%)				
	1960	1970	1980	1985	1988	1989	1990	1991p	1989	1990	1991	1960-70	1970-80	1980-85	1985-90	1985-91				
Agriculture & Fishing	182.8	267.8	325.1	292.3	205.4	191.8	177.3	160.6	-6.6	-7.6	-9.4	3.9	2.0	-2.1	-9.5	-9.5				
Quarrying	11.1	28.3	65.0	111.3	88.1	89.4	81.4	94.7	1.5	-8.9	16.3	9.8	8.7	11.4	-6.1	-2.7				
Manufacturing	839.3	3,021.7	8,500.1	9,184.3	13,773.2	15,121.5	16,557.6	17,431.4	9.8	9.5	5.3	13.7	10.9	1.6	12.5	11.3				
Utilities	86.6	235.0	578.0	796.0	1,012.1	1,085.9	1,203.3	1,281.1	7.3	10.8	6.5	10.5	9.4	6.6	8.6	8.3				
Construction	266.5	1,152.8	2,005.8	4,167.9	2,804.3	2,845.0	3,050.0	3,690.5	1.5	7.2	21.0	15.8	5.7	15.8	-6.1	-2.0				
Commerce	1,243.9	2,681.8	5,452.8	6,636.3	8,560.8	9,268.9	10,026.4	10,672.0	8.3	8.2	6.4	8.0	7.4	4.0	8.6	8.2				
Transport & Communications	444.5	885.8	3,448.5	5,234.5	6,786.4	7,426.4	8,079.2	8,723.5	9.4	8.8	8.0	7.1	14.6	8.7	9.1	8.9				
Financial & Business Services	709.2	2,062.9	5,919.9	10,652.0	12,195.8	14,046.6	15,837.5	16,691.7	15.2	12.7	5.4	11.3	11.1	12.5	8.3	7.8				
Other Services	991.9	1,812.3	3,332.1	4,577.3	5,231.0	5,484.2	5,783.2	6,173.5	4.8	5.5	6.7	6.2	6.3	6.6	4.8	5.1				
Less: Imputed Bank Service Charge	53.6	160.2	1,340.8	3,196.5	2,946.7	3,466.1	4,249.8	4,555.0	17.6	22.6	7.2	11.6	23.7	19.0	5.9	6.1				
Add: Import Duties	235.8	356.1	496.0	468.1	511.2	584.4	526.6	531.9	14.3	-9.9	1.0	4.2	3.4	-1.2	2.4	2.2				
Total	5,058.5	12,172.4	28,832.5	38,923.5	48,221.6	52,678.0	57,072.7	60,895.9	9.2	8.3	6.7	9.2	9.0	6.2	8.0	7.7				

Share of GDP

	Share of GDP (%)									
	1960	1970	1980	1985	1988	1989	1990	1991p		
Agriculture & Fishing	3.6	2.2	1.1	0.8	0.4	0.4	0.3	0.3	0.3	0.3
Quarrying	0.2	0.2	0.2	0.3	0.2	0.2	0.1	0.1	0.2	0.2
Manufacturing	16.6	24.8	29.5	23.6	28.6	28.7	29.0	28.6		
Utilities	1.7	1.9	2.0	2.0	2.1	2.1	2.1	2.1		
Construction	5.3	9.5	7.0	10.7	5.8	5.4	5.3	6.1		
Commerce	24.6	22.0	18.9	17.0	17.8	17.6	17.6	17.5		
Transport & Communications	8.8	7.3	12.0	13.4	14.1	14.1	14.2	14.3		
Financial & Business Services	14.0	16.9	20.5	27.4	25.3	26.7	27.7	27.4		
Other Services	19.6	14.9	11.6	11.8	10.8	10.4	10.1	10.1		
Less: Imputed Bank Service Charge	1.1	1.3	4.7	8.2	6.1	6.6	7.4	7.5		
Add: Import Duties	4.7	2.9	1.7	1.2	1.1	1.1	0.9	0.9		
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		

Note: p: Preliminary
 Sources: Economic Survey of Singapore, 1990
 Yearbook of Statistics, 1991

**Table 2-3 Contribution to Growth in Gross
Domestic Product at 1985 Market Prices, 1988-1990**

(Unit: %)

Industry	1988	1989	1990p
Total	11.1	9.2	8.3
Manufacturing	4.4	2.4	2.1
Construction	-0.3	0.1	0.3
Commerce	2.5	1.3	1.0
Transport & Communications	1.3	1.1	0.9
Financial & Business Services	2.7	3.8	3.4
Others	0.5	0.5	0.6

Note: p = preliminary

Source: Ministry of Trade and Industry, "Economic Survey
of Singapore 1990"

Table 2-4 Labor Force and Employment, Singapore

	Labor Force (in thousand)	Employed (in thousand)	Unemployed (% of Labor Force)
1980	1,116.0	1,077.1	3.5
1986	1,228.6	1,149.0	6.5
1987	1,251.7	1,192.9	4.7
1988	1,281.4	1,238.5	3.3
1989	1,305.4	1,277.3	2.2
1990	1,347.9	1,324.7	1.7
1991	1,554.3	1,524.3	1.9

Notes: 1980: Estimated (in Mid-year, over 15-year old)

1986 and onwards: Over 10-year old

Sources: 1980: Census of Population

1986 and onwards: Economic Survey of Singapore, 1991

Table 2-5 Balance of Payments of Singapore, 1970, 1980 and 1986-1990

	(Unit: million S\$)							
	1970	1980	1986	1987	1988	1989	1990p	
A Goods & Services (net)	-1,727.2	-3,118.0	1,092.1	964.0	3,122.2	5,639.0	4,912.9	
Exports of Goods & Services	6,132.3	54,040.8	64,833.0	80,153.4	102,760.0	115,455.1	129,373.2	
Imports of Goods & Services	7,859.5	57,158.8	63,740.9	79,189.4	99,637.8	109,816.1	124,460.3	
Trade Balance	-2,619.4	-8,994.5	-4,497.3	-5,152.0	-4,719.5	-4,823.7	-9,277.7	
Balance of Services	892.2	5,876.5	5,389.4	6,116.0	7,841.5	10,462.7	14,190.6	
B Unrequited Transfers (net)	-23.6	-227.6	-398.4	-492.2	-597.4	-670.9	-654.1	
Current Account Balance	-1,750.8	-3,345.6	693.7	471.8	2,524.8	4,968.1	4,253.8	
C Capital (net)	532.6	3,388.3	-967.7	989.6	1,654.8	3,710.5	11,458.2	
Nonmonetary Sector (net)	429.1	3,096.7	2,820.8	2,799.8	3,650.1	6,329.1	8,401.7	
Monetary Sector (net)	103.5	291.6	-3,788.5	-1,810.2	-1,995.3	-2,618.6	3,056.5	
D Counterpart Item								
Allocation of Special Drawing Rights	-	14.5	-	-	-	-	-	
E Basic Balance	-1,500.3	-232.4	3,236.1	5,876.1	8,495.5	11,715.4	10,881.1	
F Balancing Item	1,783.0	1,376.6	1,482.6	867.1	-836.0	-3,344.4	-5,824.5	
G Overall Balance (A+B+C+D+F)	564.8	1,433.8	1,208.6	2,398.5	3,343.6	5,334.2	9,892.5	

Note: p = Preliminary

Source: Ministry of Trade and Industry, "Economic survey of Singapore 1990"

Table 2-6 Singapore Exports by Commodity

Commodity	1966		1965		1970		1975		1980		1985		1989		1990		1991	
	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%
Total	3,477.1	100.0	3,004.1	100.0	4,752.8	100.0	12,757.9	100.0	41,452.3	100.0	50,178.8	100.0	57,115.5	100.0	95,206.0	100.0	103,279.5	100.0
Food	461.6	13.3	435.8	14.5	549.6	11.6	915.7	7.2	2,008.2	4.3	2,193.1	4.4	3,057.1	5.3	2,734.2	2.9	3,052.8	3.0
Cereals & Cereal Preparations	154.5	4.4	82.6	2.7	156.6	3.3	125.7	1.0	610.5	1.5	186.5	0.4	254.1	0.5	188.0	0.2	209.1	0.2
Fruits & Vegetables	171.0	4.9	105.5	3.5	226.2	4.8	150.6	1.2	389.8	0.9	366.2	0.7	389.8	0.7	387.6	0.4	455.6	0.4
Coffee & Spices	70.4	2.0	46.3	1.5	71.6	1.5	40.9	0.3	157.2	0.4	240.8	0.5	386.3	1.0	1,387.8	1.5	1,540.5	1.5
Beverages & Tobacco	1,558.4	44.8	819.4	27.3	1,430.3	30.1	1,694.3	13.3	4,700.0	11.3	2,699.7	5.4	3,721.4	6.3	2,914.6	3.1	2,521.6	2.5
Crude Materials	1,431.8	41.2	677.0	22.5	1,173.3	24.7	1,320.7	10.4	3,294.1	7.9	1,496.1	3.0	1,909.0	3.2	1,425.3	1.5	1,109.5	1.1
Rubber	24.7	0.7	51.8	1.7	110.9	2.3	133.7	1.0	555.0	1.4	327.9	0.7	705.1	1.5	491.1	0.5	449.6	0.4
Wood	392.1	11.3	431.1	14.4	822.6	17.3	3,451.2	27.1	11,965.7	28.9	16,482.2	32.8	13,443.0	23.4	17,295.3	18.2	17,371.0	17.1
Mineral Fuels*2	379.2	10.9	429.7	14.3	818.1	17.2	3,407.6	26.7	11,910.0	28.5	13,456.1	26.8	11,516.8	20.2	14,371.3	15.1	14,371.3	13.9
Petroleum & Petroleum Products	50.3	1.4	60.0	2.0	140.2	2.9	245.5	1.9	1,095.5	2.6	1,535.2	3.1	1,016.1	1.8	760.7	0.8	722.1	0.7
Animal & Vegetable Oils	86.3	2.5	109.6	3.6	128.5	2.7	475.7	3.7	1,416.5	3.4	2,716.9	5.4	5,736.7	11.6	5,970.1	6.3	6,660.1	6.6
Unprocessed Vegetable Oils	12.2	0.4	18.2	0.6	22.1	0.5	173.9	1.4	325.9	0.8	917.6	1.8	1,921.1	3.8	2,109.0	2.2	2,537.1	2.5
Chemicals	314.5	9.0	356.8	11.9	423.1	8.9	1,086.5	8.5	3,411.7	8.3	3,597.8	7.2	7,055.6	12.3	6,651.3	7.0	7,320.3	7.2
Chemical Compounds	29.7	0.9	10.1	0.3	53.3	1.1	200.7	1.6	432.0	1.0	484.3	1.0	597.3	1.1	486.6	0.5	513.8	0.5
Medicinal Products	119.3	3.4	140.5	4.7	149.3	3.1	308.9	2.4	565.4	1.3	776.9	1.5	1,544.8	2.7	1,630.8	1.7	1,833.5	1.8
Plastic Materials	40.1	1.2	51.1	1.7	39.1	0.8	206.0	1.6	454.3	1.1	457.8	0.9	561.5	1.0	789.9	0.8	891.4	0.9
Manufactured Goods by Material	234.6	6.7	315.0	10.5	520.9	11.0	2,894.6	22.7	11,089.4	26.6	16,567.4	33.0	43,142.3	75.5	47,732.6	50.1	51,666.7	50.0
Wood Manufactures	107.7	3.1	107.7	3.6	889.8	18.7	889.8	7.0	889.8	2.1	6,011.5	12.0	19,959.1	34.9	23,057.6	24.2	24,998.9	24.2
Textile Manufactures	51.1	1.5	51.1	1.7	153.7	3.2	1,471.9	11.5	4,103.3	9.9	8,855.0	17.6	20,471.9	35.8	22,223.2	23.3	24,542.2	24.1
Iron & Steel	82.4	2.4	153.7	5.1	126.7	2.7	533.0	4.2	1,410.3	3.4	1,701.0	3.4	1,731.2	3.0	2,451.7	2.6	2,155.5	2.1
Metal Manufactures	99.4	2.9	153.0	5.1	247.9	5.2	880.4	6.9	2,572.4	6.2	3,378.2	6.7	7,815.3	13.7	8,499.7	8.9	9,225.9	9.1
Machinery & Transport Equipment	25.9	0.7	50.4	1.7	94.7	2.0	277.8	2.2	912.5	2.2	1,176.5	2.3	2,715.1	4.8	2,867.2	3.0	3,088.5	3.0
Non-electric Machinery	19.0	0.6	19.0	0.6	19.0	0.4	295.4	2.3	912.5	2.2	660.4	1.3	1,740.0	3.0	1,953.1	2.1	2,177.6	2.1
Electric Machinery	277.1	8.0	277.1	9.2	1,073.1	22.6	1,073.1	8.4	1,073.1	2.6	797.5	1.6	1,234.9	2.2	1,259.7	1.3	1,465.2	1.4
Transport Equipment																		
Miscellaneous Manufactured Articles																		
Clothing																		
Scientific & Optical Instruments																		
Watches & Clocks																		
Miscellaneous Transactions nec																		

Notes: *1: Include Fruits & Vegetables.

*2: Include oil bunkers.

*3: Veneer & Plywood

*4: Textile Yarn & Fabrics

Sources: Economic Survey of Singapore, 1988
Yearbook of Statistics Singapore, 1991

Table 2-7 External Trade of Singapore

	Exports				Re-exports	Imports	Trade Balance
	Total	Domestic Exports		Sub-total			
		Oil	Non-oil				
Value (Million S\$)							
1960	3,477	217			3,260	4,078	-601
1970	4,756	1,832			2,924	7,534	-2,778
1980	41,452	25,805	14,180	11,625	15,647	51,345	-9,893
1981	44,291	29,452	16,778	12,674	14,838	58,248	-13,957
1982	44,473	29,158	17,161	11,997	15,315	60,245	-15,772
1983	46,155	29,206	15,234	13,973	16,949	59,504	-13,349
1984	51,340	33,051	15,744	17,307	18,289	61,134	-9,794
1985	50,179	32,576	15,840	16,735	17,603	57,818	-7,639
1986	48,986	32,062	11,980	20,082	16,924	55,545	-6,559
1987	60,266	39,071	11,754	27,317	21,195	68,415	-8,149
1988	79,051	49,555	11,341	38,214	29,496	88,227	-9,176
1989	87,116	55,252	13,234	42,028	31,864	96,864	-9,748
1990	95,206	62,754	17,137	45,618	32,452	109,806	-14,600
1991	101,880	66,031	17,201	48,829	35,848	114,195	-12,315
Changes (%)							
1981	6.8	14.1	18.3	9.0	-5.2	13.4	
1982	0.4	-1.0	2.3	-5.3	3.2	3.4	
1983	3.8	0.2	-11.2	16.5	10.7	-1.2	
1984	11.2	13.2	3.3	23.9	7.9	2.7	
1985	-2.3	-1.4	0.6	-3.3	-3.7	-5.4	
1986	-2.4	-1.6	-24.4	20.0	-3.9	-3.9	
1987	23.0	21.9	-1.9	36.0	25.2	23.2	
1988	31.2	26.8	-3.5	39.9	39.2	29.0	
1989	10.2	11.5	16.7	10.0	8.0	9.8	
1990	9.3	13.6	29.5	8.5	1.8	13.4	
1991	7.0	5.2	0.4	7.0	10.5	4.0	
Av. Annual Growth (%)							
1960-70	3.2	23.8			-1.1	6.3	
1970-80	24.2	30.3			18.3	21.2	
1980-85	3.9	4.8	2.2	7.6	2.4	2.4	
1985-90	13.7	14.0	-6.5	9.6	13.0	13.7	
1985-91	12.5	12.5	1.4	19.5	12.6	12.0	

Sources: Economic Survey of Singapore 1974 and 1990
Yearbook of Statistics, Singapore, 1991

Table 2-8 Exports to the Selected Countries by Area, Singapore

(Unit: million S\$)

Country/Area	1960		1965		1970		1975		1980		1985		1989		1990		1991	
	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%
Total	3,477.1	100.0	3,004.1	100.0	4,755.8	100.0	12,757.9	100.0	41,452.3	100.0	50,178.8	100.0	87,116.5	100.0	95,206.0	100.0	101,879.4	100.0
America	406.2	11.7	212.9	7.1	647.1	13.6	2,219.3	17.4	6,062.7	14.6	12,005.9	23.9	22,249.7	25.5	22,389.4	23.5	22,595.5	22.2
United States	242.2	7.0	124.9	4.2	527.3	11.1	1,755.4	13.8	5,272.0	12.7	10,619.0	21.2	20,290.8	23.3	20,245.5	21.3	20,103.0	19.7
Asia	1,850.6	53.2	1,887.2	62.8	2,550.9	53.6	6,676.9	52.3	22,997.9	55.5	27,293.0	54.4	45,666.7	52.4	50,517.6	53.1	56,030.8	55.0
Hong Kong	60.0	1.7	132.8	4.4	194.0	4.1	937.0	7.3	3,195.9	7.7	3,197.4	6.4	5,505.4	6.3	6,186.1	6.5	7,346.5	7.2
Japan	156.7	4.5	112.2	3.7	361.5	7.6	1,112.9	8.7	5,338.3	12.9	4,722.2	9.4	7,447.7	8.5	8,301.5	8.7	8,836.4	8.7
Korea, Rep of	na	na	na	na	34.7	0.7	na	na	621.9	1.5	619.5	1.2	1,685.0	1.9	2,108.1	2.2	2,407.8	2.4
Malaysia	1,022.5	28.8	1,220.3	40.6	1,039.7	21.9	2,188.2	17.2	6,218.0	15.0	7,786.7	15.5	11,914.8	13.7	12,448.5	13.1	15,236.1	15.0
Philippines	57.8	1.7	13.4	0.4	13.0	0.3	135.7	1.1	586.1	1.4	478.6	1.0	1,294.4	1.5	1,215.1	1.3	1,175.8	1.2
Taiwan	7.5	0.2	na	na	37.5	0.8	na	na	702.0	1.7	855.2	1.7	2,622.0	3.0	3,421.8	3.6	3,621.0	3.6
Thailand	107.3	3.1	68.0	2.3	156.8	3.3	445.4	3.5	1,809.3	4.4	2,092.5	4.2	4,805.7	5.5	6,310.3	6.6	6,408.6	6.3
Europe	926.3	26.6	648.9	21.6	1,136.6	23.9	2,265.2	17.8	6,632.7	16.0	6,551.9	13.1	13,811.7	15.9	16,554.1	17.4	17,235.7	16.9
West Europe	745.8	21.4	476.0	15.8	889.5	18.7	2,040.0	16.0	5,807.9	14.0	6,020.2	12.0	13,434.6	15.4	15,957.0	16.8	16,595.6	16.4
Oceania	201.6	5.8	148.8	5.0	231.3	4.9	1,163.3	9.1	3,281.0	7.9	3,062.0	6.1	5,694.9	6.5	3,725.4	3.9	3,811.3	3.7
Africa	na	na	106.3	3.5	na	na	433.1	3.4	na	na	1,266.0	2.5	1,693.5	1.9	2,019.5	2.1	2,206.1	2.2

Source: Economic Survey of Singapore, 1988
Yearbook of Statistics Singapore, 1991

Table 2-9 Principal Statistics of Manufacturing by Major Industry Group, 1990

Industry	Establishments		Output		Output per Establishment (mil. S\$)	Employment (persons)	Workers per Establishment (persons)
	(no.)	%	mil. S\$	%			
Electronic Products	245	39.1	27,631.8	39.1	112.8	125,449	512
Transport Equipment	230	5.3	3,717.3	5.3	16.2	25,092	109
Petroleum Products	11	16.1	11,416.5	16.1	1,037.9	3,202	291
Fabricated Metal Products	472	5.1	3,619.8	5.1	7.7	28,181	60
Machinery except Electrical & Electronic	400	4.5	3,158.0	4.5	7.9	24,243	61
Industrial Chemicals & Gases	73	4.6	3,239.6	4.6	44.4	4,766	65
Paints, Pharmaceutical & Other Chemical Products	91	2.6	1,817.4	2.6	20.0	5,094	56
Printing & Publishing	326	2.4	1,726.8	2.4	5.3	15,664	48
Electrical Machinery, Apparatus & Appliances	131	3.4	2,367.9	3.4	18.1	21,733	166
Food	266	3.1	2,199.6	3.1	8.3	10,592	40
Wearing Apparel	371	2.4	1,719.6	2.4	4.6	28,086	76
Other Products	1,107	11.4	8,086.1	11.4	7.3	60,387	55
Total excl. Rubber Processing	5,723	100.0	70,700.4	100.0	19.0	352,489	95
Rubber Processing	5		205.0		41.0	187	37
Total incl. Rubber Processing	5,728		70,905.3		19.0	352,676	95

Notes: Refers to establishments engaging 10 or more persons.

Source: Ministry of Trade and Industry, "Economic Survey of Singapore 1990"

**Table 2-10 Comparison between Local & Foreign
SME Performance in Manufacturing**

		Local SMEs	Foreign SMEs
Establishments (a)	(in thousand)	2.7	0.5
Employment (b)	(in thousand)	99.1	44.9
(b/a)	(persons)	36.7	89.8
Value Added (c)	(billion S\$)	2.6	1.8
(c/a)	(1,000 S\$)	963.0	3,600.0
Direct Exports (d)	(million S\$)	2,809	2,933
(d/a)	(1,000 S\$)	1,040	5,866
(d/c)	(%)	108	163
Net Fixed Assets per Worker (e)	(1,000 S\$)	19.1	24.9
Value Added per Worker (f)	(1,000 S\$)	25.7	39.7

Source: SME Committee, EDB, "SME Master Plan (Report on Enterprise Development)", (original data from "Census of Industrial Production, 1987")

Table 2-11 Cost Structure of Manufacturing

Capital Structure	Inputs	Work given out	Other Costs of Production	Output	(a/b)
		(a)			(b)
Wholly Local	6,146	1,088	1,210	10,769	10.1
More than Half Local	3,347	738	743	6,447	11.5
Less than Half Local	7,657	186	799	9,854	1.9
Wholly Foreign	29,686	878	3,829	44,264	2.0
Total	46,837	2,890	6,581	71,333	4.1

Source: EDB, "Report on the Census of Industrial Production 1990"

Table 2-12 The Industries where SMEs have Achieved Above-Industry Average Performance or Possess Good Potential for Growth

• Supporting Industries

- Plastic moldings and precision machining
- Packaging materials
- Metal finishing and stamping
- Precision engineering and tooling
- Printed circuit board assemblies
- Electro-mechanical assemblies
- Semiconductor testing services
- Waste recycling and treatment

• Industries with High Export Potential

- Printing and publishing
- Jewellery
- Fashion apparel
- Designer furniture and interior furnishings
- Convenience foods
- Material handling equipment
- Industrial air-conditioning and refrigeration equipment
- Communication equipment
- Computers and computer peripherals
- Hybrid circuits
- Precision optics
- Instrumentation and control equipment

Source: SME Master Plan

3 Packaging-Related Issues Facing Major Industrial Users

This chapter identifies the current state of packaging operations by major manufacturing industries in Singapore, namely the electronics/electrical industry, the food industry, and the chemical and pharmaceutical industry, as well as major issues facing them. Then, what they expect and need from the packaging sector and the packaging technology center will be analyzed. Note that the issues and needs discussed are not limited to those felt by the user industries, but including potential issues and needs which will require attention in due course from an international perspective.

The food and beverage industry, the electronic and electrical industry, the chemical and pharmaceutical industry – major industrial users of package materials in Singapore – consume 40.0%, 22.1%, and 20.2%, respectively, of total consumption by all the manufacturing industries on a value basis, with a combined share of 82.3%.

3.1 Electronic and Electrical Industry

3.1.1 Major Trends in the Electronic/Electrical Industry

3.1.1.1 General

Electronic equipment and components are generally classified into the following 3 categories: (1) consumer electronics equipment for personal or household use, (2) industrial electronic equipment for capital investment, and (3) electronic components used for assembly of the above equipment. Consumer electronic equipment includes household appliances and audio systems. Industrial electronic equipment includes telecommunications equipment and computers, and electronic components and parts cover semiconductors and general electronic components. Electrical equipment includes: (1) household appliances such as refrigerators and air-conditioners, (2) industrial equipment including transformers and motors, (3) dry and storage batteries, (4) light bulbs, and (5) cables and wires.

Worldwide demand for electronic equipment amounted to US\$549.2 billion in 1988, of which the U.S. held the largest share of 34%, totaling US\$188.1 billion (Table 3-1), followed by Western Europe (US\$141 billion with a 26% share) and Japan (US\$110.3 billion with a 20% share). On the other hand, demand in Asia other than Japan was

US\$40.1 billion, merely 7% of the world total. With the rapid economic development and industrialization being expected, however, the Asian market is likely to record strong growth.

Among electronic and electrical products, high growth is expected in electronic component and industrial electronic equipment segments. Major impetuses for growth of electronic components are the increase in equipment using such components and the increase in the number of components per equipment. In particular, electronic devices such as semiconductor devices and integrated circuits are expected to show the most notable growth. In the industrial equipment sector, computer demand – mainly personal computers and workstations – will grow significantly.

The largest producing country is the U.S. which output amounts to US\$162.6 billion, or slightly below 30% of world production of electronic equipment and components. The U.S. production accounts for 86% of domestic demand. Japan produces US\$160.6 billion (29%) and Western Europe US\$117.5 billion (21%). Production in Asia excluding Japan amounts to US\$59.2 billion, 10% of the world total. In the future, Europe, the U.S., and Japan will lose their shares, whereas Asia's share will increase steadily. (Table 3-2)¹⁾

3.1.1.2 Overseas operation of electronic industries of industrialized nations

(1) Preface

The overseas production of the electronics industry from industrialized countries was at first to secure a foothold in the foreign market. Gradually, however, this evolved into the international trend to develop overseas production bases. The items to be produced are decided based on that country's relationship with major export markets (such as availability of preferential duties, and so forth), and the state of its support industries, among others.

In the case of Japan's electronics industry's overseas production bases, over 50% produce passive components, about 25% functional components and around 15% produce mechanical parts and components while the bases producing active components do not exceed 10%. However, this figure varies depending on the region, as there is a great deal of production of active components in the overseas production bases in Europe and North America. In these regions, many countries have import regulations on integrated circuits, semi-conductors and CRTs, among others. Thus, the nature of production there is to secure the local markets. At the same time, support industries are already in place making possible the production of active components in these countries.

¹⁾ Forecast by Japan Electronic Industry Development Association (May, 1990)

On the other hand, in Central America, South Korea and Malaysia, among others, where a large part of the production process of many passive components is labor-intensive, the materials are imported.

It is also possible to attribute special characteristics to the production bases overseas from the point of the number of items produced per base. Countries with large domestic markets like Taiwan and South Korea where not only components but also, equipment is exported, in many cases the number of items produced per base is 1.5–1.6 items. Compared to this, in Singapore and Malaysia, where the production of components for export is the special characteristic, the figure are small, 1.1–1.3 items per base.

The international development of the electronics equipment and component industry, as shown below can be seen in terms of two trends. These are 1) the development of overseas production of electronics equipment and the parallel development of the production of components and 2) the development of overseas production of semi-conductors.

(2) Development of overseas production of electronics equipment

The overseas production of electronics equipment began sometime ago, a large part was aimed at the production of consumer electronics equipment for local domestic demand. At first it began with the local assembly of components sent by the parent company and the final products were sold in the local market. Thereafter, the demands in each country to localize production became stronger. In response to this, each manufacturer moved towards the procurement of necessary components within the country. In many cases, however, the items produced depend on the demands of that country.

Towards the latter half of the 1970's, another trend emerged wherein overseas production was seen as a way to avoid trade friction. In the beginning the focus was the production of color TVs. The production of color TVs in Japan was transferred overseas, sharply decreasing domestic production.

The production system in Japan was reformed to cope with the decline in production due to the transfer overseas and as a result, the development of VTRs advanced rapidly. Of course the component manufacturing companies also changed their products to match this shift.

The main factors for the promotion of overseas production during this period were 1) the worsening trade friction, 2) the rise of the electronics equipment manufacturers in NIEs, 3) the shift of demand in the industrialized countries' domestic markets from equipment for consumer use to industrial use equipment, 4) the necessity to reform the production system as a result of the opening of China's market, among others.

The strengthening of the Yen from 1985 onwards again encouraged overseas production. As for each type of electronics equipment, there was a rise in the number of production plants built for the purpose of exporting from the overseas production bases to a third country or to the home market. In such cases, products are specialized to specific items, and the scale of production is large to match the export market.

Since then, the manufacturers aimed for the horizontal international specialization. That is, the strategy was to move the production of low and medium quality products to ASEAN & NIEs and the high quality goods were manufactured in Japan. For example, in the case of audio equipment, in Japan the focus of items being produced was changed from radio cassettes, to new types of products, such as car audio equipment, digital audio disk players, etc. As a result many radio cassettes are imports. Also, in the case of Taiwan, the production of radio cassettes has gradually decreased, but on the other hand, the proportion of stereo record players and CD players produced has grown. In contrast, the production of radio cassettes in Singapore and Malaysia have increased while the production of radios has declined. Even in the case of color TVs, in Japan, 19 inch models or less are produced overseas and there is a trend to produce large types or value-added products within the country.

In Japan and other industrialized countries, because of severe market competition, the life cycle of electronics products is becoming shorter. In response to this, however, the system is steadily being established. It can be said that one of indicator is the international change of items produced. As a countermeasure, first, there was an effort to shorten the lead time for product development. Through this, in response to trends in the market, it became possible for new products to be development in a shorter period and then delivered to the market. For the formation of such a system, other than technical solution by means of introduction of CAD, an important role was played by a joint development work of manufacturers of electronics equipment and components. They also utilized, from the initial stage, the capability of their surrounding industries for research and development. In other words, the existence of components manufacturers with the research development capability made the system viable. At the same time, it is understood that the overseas production is not appropriate for products which need to respond to kaleidoscopic changes of demand.

Also, advance in insertion technology was an important factor in the system as it contributed to the automation of the labor intensive printed circuit board assembly process. This is resulted in a countermeasure to the strong yen and the hike in labor costs.

Meanwhile, effort was also made to bring cost down shifting production of technologically stabilized products overseas. Initially overseas production of middle level items commenced with a system to carry out the final stage of production in low-labor cost countries having kit components exported. However, within Japan, the cost of labor rose and from 1985 with the advancement of the rise of the yen, the cost of the kit components increased. Due to this, local production companies pursued measure to bring cost down increasing the percentage of local procurement.

In order to support this, an expansion of parts makers overseas took place together with the shift of production overseas of the electronics equipment manufacturers. This supplemented the shortage of local supporting industries.

As further once of the policy to develop overseas production bases, a measure is pursued to procure, as much as possible, from overseas sources for necessary parts for the domestic production in Japan or the production in the country than Japan, instead of exports from Japan.

(3) Development overseas production of semiconductors

In the case of semiconductors, the situation is slightly different from the cases of electric and electronics equipment. A production process of semiconductors companies the wafer fabrication process which processes silicon wafers to silicon chips for semiconductors and the assembly process. Once the semiconductors production enterprises concentrated in the Silicon Valley in the USA. They moved overseas where low cost labor was available for a labor intensive assembly process as a result of a hike of labor cost in 1970s. Though the assembly process is said to be labor intensive, the work force at a certain high standard is essential in order to secure a yield and raise the productivity since the assembly process contains fabrication and inspection steps which need to be more microscopic and precise than the assembly work of automobiles and consumer electronics appliances. Moreover, preferential measures on the investment, import and export were also needed as all the necessary materials were brought in and the produced parts were taken back to the USA. Eventually, production developed concentrating in such specific countries as Malaysia where these conditions were fulfilled. Recently, a part of the wafer fabrication process has also been shifted overseas.

Meanwhile, in the case of Japan, most of the semiconductor production enterprises remain in Japan as their production lines have been automated to cope with the rise of labor costs. However, there are a few cases of the shift of production to the present export markets where trade friction is anticipated.

3.1.1.3 Electronics equipment and components industries in Asia

As indicated above, the production development of electronics equipment and components in the developing countries shows the following particularities.

- 1) Importance is given to using these production sites in the developing countries as export bases.

In particular, the active transfer of technically reliable and stable products is promoted.

- 2) There is an expansion of local components production. Enhancement of production by indigenous local industry in addition to the enhancement of local in-house production by equipment manufacturers or production by affiliate components manufactures in the industrialized countries.
- 3) There is an expansion of components imported by the parent company from its overseas production bases, and an expansion in the OEM supplies directed to the NIEs. There is also an expansion of imports of NIEs origin to the mother country. These trends further the international division of labor and result in a reorganization of the domestic industrial structures.

In the context of the above evolution, the countries besides Singapore and Taiwan which are given most emphasis as export production bases in the Asian region are Thailand and Malaysia.

Looking at geographical distribution of the 1992 production in Asia, large volume of headphone stereos and cassette tape recorders are produced in Malaysia and Singapore, VCRs in South Korea, hard disk drives in Singapore, and CRTs in South Korea and Taiwan. Naturally, such distribution has been changing constantly, and production of less technology-intensive products are gradually shifted to other Asian countries which can offer lower labor cost.

A primary example is Thailand which has successfully attracted Japanese manufacturers, followed by Korean and Taiwanese firms, in order to establish export production bases in the recent few years. In the process, production of electronic equipment and components expanded appreciably. However, further growth may be limited by the delay in development of infrastructure required for production of products, complicated export and import procedures, and the limited number of suppliers. In fact, as the country's wage level has already reached a comparatively high level, production of audio systems and other low value added products is being shifted to China.

Another newly emerged electronic production base is Malaysia which was previously dominated by electronic components, accounting for 84% of electronic products produced in the country in 1984. Electronic components were mostly ICs which were manufactured by semiconductor makers from Europe, the U.S., and Japan for export, mainly to the U.S. As the government initiated an aggressive policy to foster the electronic equipment industry and to attract foreign investment, electronic components lost their share of total production after 1985. In particular, active investment by Japanese electronic equipment makers has boosted a share of consumer and industrial electronic equipment production at an accelerated rate.

3.1.2 Electronic and Electrical Industry in Singapore

3.1.2.1 General

The value added by the electronic and electrical industry in Singapore represents one third that by all the manufacturing industries, commanding an important position in the country's economy. The industry consists of multinational corporations and local companies, both of which produce consumer and industrial products in finished, semi-finished, or component forms. Products are primarily destined to export markets, including the U.S., EC, Japan, and Asian countries. The U.S. is the largest export market and its economic condition significantly affects the industry's operation. At present, multinationals from Europe, the U.S., and Japan are dominating the industry in terms of both production and exports. On the other hand, local companies are relatively small in production and export capabilities, thus holding a small share of the entire industry.

Major products in the industrial equipment segment are disk drives, computers, telecommunications equipment, and printers, as well as consumer equipment including color TVs, radio/cassette tape recorders, and stereos, and electronic components mainly consisting of ICs, picture tubes, capacitors, and resistors.

Back in the 1960s, demand for electronic and electrical products in Singapore largely came from the British forces stationed in the Far East, and it was mainly satisfied by imported products. Then, with the independence of Singapore from Malaysia in 1965 and the withdrawal of the British forces in 1968, manufacturing industries in Singapore – including the electronic/electrical industry – lost sizable markets. Under the strategy to foster export industries, the government adopted a policy to attract foreign investment and designated the electronic/electrical industry as a pioneer industry eligible for various incentives. Electronic and electrical manufacturers in industrialized countries began to realize the value of Singapore as a key export base. In particular, the U.S. and European

makers established IC assembly facilities to enjoy low labor cost. Also attracted were consumer electronic equipment makers from Japan, as well as the U.S. and Europe.

In the 1970s, the country's foreign investment policy was shifted from the welcoming of all the industries to the focusing on industries who have technological resources to produce high value products supported by export markets. With the favorable investment climate marked by excellent locational advantages, well-developed infrastructure, high levels of education and skills, and political stability, Singapore has attracted a wave of foreign investment, particularly multinational corporations based in Europe and the U.S.

After 1985, the shortage of labor supply and the rise in labor cost have surfaced, and with industrialization of neighboring countries, many foreign makers have shifted the focus of their operations in Singapore from simple assembly and processing to key activities including the development of next-generation technologies and products or a regional production base in Southeast Asia. As a result, assembly operations have been relocated to Malaysia, Thailand and other ASEAN countries, while upgrading production facilities in Singapore to be increasingly responsible for high value products featuring multiple functions and compact size. Also, some multinationals have established product development and technical service divisions in Singapore, which serve production bases in Southeast Asia and other regions.

3.1.2.2 Production and export

The values of production and exports of electronic and electrical equipment and components in Singapore have been steadily growing, except for some setback in 1985. Notably, growth has accelerated after 1987. The total valued added by the industry is the highest among all the manufacturing industries, while the value added per employee is nearly the overall average. About a decade ago, both the value of production per employee and the value added per employee were below the average for the manufacturing industry. Then they grew rapidly with the shift of product lines to high value ones and the progress of automation; the value of production per employee increased nearly threefold from S\$82,000 in 1981 to S\$227,000. On the other hand, the value of electrical machinery production per employee recorded a merely 70% increase during the same period, from S\$63,000 to S\$111,000 (Table 3-3, Figure 3-1). In 1991 and 1992, however, production and exports of electronic and electrical products remained sluggish due to the worldwide recession.

In 1990, Singapore imported S\$2,060,140,000 worth of electronic and electrical products and components from Thailand, compared to total imports of S\$3,628,846,000. On the other hand, electronic and electrical exports to Thailand amounted to

S\$1,690,702,000, out of S\$1,912,471,000. Major items of imports from Thailand are semi-finished products and components, including computer components and peripherals, color TVs, speakers, TV/radio/VCR components and parts, picture tubes, and general electronic components. This reflects the fact that Singapore imports electronic and electrical components and sub-assemblies from neighboring countries for final assembly or re-exporting to other countries.

Major export items from Singapore to Thailand are computer components and peripherals, color TVs, TV/radio components and parts, picture tubes, and ICs. Among them, color TVs, radio components and ICs are mostly manufactured in other countries and are re-exported to Thailand via Singapore. (Table 3-4) Thus a high percentage of re-exported components and parts in exports to Thailand, and the similarity between export and import items are major characteristics of electronic trade between the two countries. These clearly indicate that Singapore is now serving as a distribution and procurement center for electronic components in the region, as evidenced from the fact that companies having production facilities in Thailand have IPOs in Singapore.

Another major trade partner is Malaysia. Singapore imports color TVs, and TV/radio/VCR components and parts and exports picture tubes for color TVs, ICs, and TV/radio components and parts from Malaysia (Table 3-5). Among the export items, nearly half of TV/radio components and parts are re-exported. This reflects the fact that color TV makers in Malaysia procures picture tubes and other components from other countries via IPOs in Singapore, and assemble and export them. Singapore imports from Malaysia S\$932,790,000 worth of color TVs, and most of which are re-exported.

Similarly, ICs produced in Malaysia are exported via Singapore or Hong Kong to Asian countries, and many IC makers have overseas headquarters in Singapore or Hong Kong.

Malaysia is increasingly selected by foreign electronics makers as an alternative production base to Singapore for the reason of cheaper and abundant labor force. At the same time, the government of Singapore encourages labor-intensive industries to move outside, and not only foreign enterprises but also local enterprises are increasingly relocating their production facilities to Malaysia.

Singapore's imports from Japan are dominated by ICs and TV/radio/VCR components, reflecting the fact that some of Asian countries including Thailand and Malaysia import components for local assembly via Singapore. On the other hand, Japan's electronic imports from Singapore are relatively small, because Japanese makers operating in

Singapore export their products directly to Europe, the U.S., and other Asian countries. (Table 3-6)

Originally, Japanese electronics/electrical makers which built production facilities in Asia aimed to produce color TVs and audio systems for export to industrialized countries. Then rapid economic growth of Asian countries has increased the importance of Asia as a market, and Japanese makers have shifted their focus of investment to establish an export base for each regional market. This reflects the strategy in which they divide the world market into several regions and establish companies to serve as regional headquarters, around which a complete production network is formed and operated. One ramification of the strategy is horizontal division of labor within the Asian region, e.g., subsidiaries of a Japanese maker in Malaysia may become responsible for integrated production of color TVs and exports to Europe and the U.S., while those in Thailand focus on production and exports of refrigerators and washing machines.

Note that exports from Singapore are mainly made by maritime transport, but small electronic products such as disk drives and ICs are often exported by air. In addition, trucks are used to ship products to certain areas of Malaysia and Thailand. Distribution service is provided by affiliated companies of major carriers, or local or international distributors.

3.1.2.3 General profiles of electronic equipment manufacturers

Measured by the number of employee per establishment, the electronic product component industry is larger than the electrical machinery, apparatus and appliances industry and the entire manufacturing industry, and relatively a large percentage of enterprises employs 100 or more persons. The average number of employees in the industry is 500 or more. In particular, there are many disk drive makers which employ 1,000 or more persons.

Both in the electronics and electrical industries, foreign companies account for 40% to 50% of total in number. Many of them are from Japan and the U.S. Japanese companies are mainly general electronics/electrical manufactures, and the U.S. companies are manufacturers of disk drives, semiconductors, and telecommunications equipment. Japanese makers are accompanied by a large number of suppliers, who produce a variety of components such as speakers, coils, small motors, and magnetic heads, each accounting for more than 90% of total production in Singapore.

(1) Consumer electronic equipment

Many multinational corporations based in Europe, the U.S., and Japan are operating in Singapore to produce VCRs, stereos, TVs, and radio cassette recorders. Production of consumer electronic equipment in Singapore has been on the rise on a value basis, while unit production has been on the declining trend, reflecting the shift of production to products with higher value added, such as cassette tape recorders with CD players and large-screen TVs. At the same time, some of household appliance makers are relocating a whole or part of their production lines to neighboring countries, notably Malaysia, Thailand, and Batam Island (Indonesia), for lower labor cost. For instance, a U.S. telecommunications equipment maker has relocated production of cord telephones outside Singapore, while change the production line to cordless telephone. Other foreign makers have shifted labor-intensive operations part to Thailand and Malaysia.

Among consumer electronic equipment, color TVs and radio cassette tape recorders represent a large portion of exports from Singapore. Importing countries are widely varied, including the U.S., Japan, EC, and Asian countries. Notably, re-exports account for 40% to 60% of total exports, since products imported from Japan are re-exported to other countries or products manufactured in Malaysia are exported via Singapore.

TV and audio/video equipment manufacturers are relatively large in size, with the average employment of 960 and 1,280 persons, respectively. These makers export as much as 90% of total production. (Table 3-7)

(2) Industrial electronic equipment

In Singapore, industrial electronic equipment including desk-top computers, notebook computers, mother boards, disk drives and other peripherals are manufactured or sub-assembled.

The largest segment is disk drives, and the value of exports in 1991 amounted to S\$6,967 million, accounting for 16.5% of total exports by the electronics industry. Within the disk drive segment, production is being shifted to large capacity, small drives for which demand ramps up. Singapore's position as the major disk drive production base comes from availability of competent engineers and high quality components.

Nearly one half of disk drives, PCs, and peripherals exported are destined to the U.S. Other importing countries are the Netherlands, Germany, Taiwan, Hong Kong, Malaysia, and Japan. The percentage of re-exports is lower than consumer equipment.

In addition, exports of office machinery including printers, electronic typewriters, and facsimile machines are on the rise. As the U.S. economy makes a further recovery, exports of PCs and peripherals including hard disk drives are expected to increase.

Compared by corporate size, there are many hard disk drive makers which employees exceed 1,000 persons, whereas PC and peripheral makers are much smaller, with higher value added per employee. Finally, local companies are mainly doing production subcontracted from foreign makers.

(3) Components

Many semiconductor makers from Europe, the U.S., and Japan have production bases in Singapore, making the country one of the large semiconductor production facilities in the world. Today, IC production in Singapore is being shifted to highly integrated, high value memories, with IC design, test software development, and IC package development capabilities being added.

In addition, production of passive components such as capacitors, resistors, and PCBs increases in response to the rise in demand in the Asian market.

92% of ICs produced in the country (on a value basis) are exported, the highest percentage next to hard disk drives. The U.S. is the largest export market, accounting for 38% of total, followed by Asian countries such as Taiwan, Hong Kong, Japan, and Malaysia. On the other hand, general electronic components are mostly consumed by local electronics makers, with a small percentage being exported. Nevertheless, they are incorporated into export products.

In terms of corporate size, the semiconductor industry ranks medium-size in the electronics industry, with the average number of employees being 650 persons. On the other hand, general electronic component makers are much smaller in size as well as value added per employee.

3.1.2.4 Future direction of the electronics industry in Singapore

Today, the electronics industry in Singapore is facing the rise in labor cost and the increase in production of electronic equipment and components in neighboring countries. To maintain and build on the current success, the industry must differentiate itself from competitors in industrialized countries as well as neighboring countries by establishing competitive edges. The key to the successful implementation of such a strategy lies in shift to production of advanced electronic equipment and components – a far-reaching goal for neighboring countries.

In the process of industrialization, Singapore has been successfully attracting a number of multinational corporations, including electronics makers. While the multinationals require a pool of suppliers to support their production activities, they have been importing most of required components and sub-assemblies from nearby countries or procuring from foreign suppliers who have also established their production facilities in Singapore. Local

companies generally lack the technical level to satisfy requirements of the world-class manufacturers, thus has so far played a very small role in development of the electronics industry in the country.

Today, further advancement of the electronics industry can be achieved through the reinforcing of R&D activities, which require related industries who can provide a variety of small-lot processing and production services within the country. Clearly, the present pool of foreign-affiliated suppliers is not enough to meet demand, and the fostering of local industries is essential.

The government of Singapore is vigorously promoting the development of the electronics industry and has been investing in improvement of infrastructure related to communication and transportation, development of human resources, and the nurturing of supporting industries. At the same time, the government is active in supporting corporate R&D activities. As part of such efforts, National Science and Technology Board (NSTB) has established, jointly with EDB, the fund to support research and investment projects contributing to industrial development, in an attempt to strengthen international competitiveness of the manufacturing industries in Singapore.

In the area of human resource development, the government has established several centers to train engineers who can lead the development of the manufacturing industries, namely the Institute of Microelectronics, the Institute of Manufacturing Technology, and Magnetic Technology Centre, while adding new courses on electronics, mechanical engineering, and materials engineering to engineering departments of universities and technical colleges. Also, the University of Singapore and the Nanyang Technological Institute are offering courses for engineers working for companies to learn advanced technologies. EDB recruits overseas Singaporeans and other nationals working in Europe, the U.S., and Asian countries.

The government policy, well-educated labor force and well-developed industrial infrastructure have successfully positioned Singapore as an ideal location for regional supporting and/or R&D centers of multinational corporations. For instance, Japanese corporations have 4 R&D institutes in the country, the largest in Asia. Also, Singapore boasts the largest number of companies serving as regional headquarters in Asia and Oceania. Notably, the U.S. and European companies – led by U.S.-based multinationals, which are relatively remote from Asia, are finding regional headquarters and/or R&D centers in Singapore.