

JICA STUDY ON DEVELOPMENT OF PACKAGING CENTRE IN THE REPUBLIC OF SINGAPORE (SUMMARY)

No. 37

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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

**STUDY
ON
DEVELOPMENT OF PACKAGING CENTRE
IN
THE REPUBLIC OF SINGAPORE
(SUMMARY)**

SEPTEMBER 1993

SEPTEMBER 1993


JICA INTERNATIONAL COOPERATION AGENCY

**UNICO INTERNATIONAL CORPORATION
JAPAN PACKAGING INSTITUTE**

TOKYO, JAPAN

JICA
119
63.6
MPI
LIBRARY

M P I
J R
93-132

JICA LIBRARY

1115442[4]

26676

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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

**STUDY
ON
DEVELOPMENT OF PACKAGING CENTRE
IN
THE REPUBLIC OF SINGAPORE**

(SUMMARY)

SEPTEMBER 1993

**UNICO INTERNATIONAL CORPORATION
JAPAN PACKAGING INSTITUTE**

TOKYO, JAPAN



国際協力事業団

25676

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

Table of Contents

Executive Summary

Summary

1 Background, Objectives and Scope of the Study	1
1.1 Background and Objectives.....	1
1.2 Scope	1
2 Industrial Development in Singapore.....	3
3 Present Conditions and Development Issues of the Packaging Industry in Singapore	7
3.1 Overview.....	7
3.2 Paper and Board Container Sector	8
3.3 Metal Container Sector.....	10
3.4 Plastic Container Sector.....	11
3.5 Wooden Container Sector.....	13
4 Packaging--Related Issues Facing Major Industrial Users.....	14
4.1 Electronic and Electrical Industry	14
4.2 Food and Beverage Industry.....	18
4.3 Chemical and Pharmaceutical Industry.....	21
4.4 Other Industries	23
5 Packaging Technology Center Development Plan.....	25
5.1 Areas of Improvement for the Packaging Sector.....	25
5.2 Actions Required for Development of the Packaging Sector and Role Played by the Packaging Technology Center	27
5.3 Recommended Development Plan for Packaging Technology Center	31
5.3.1 Framework of the Plan.....	31
5.3.2 Development Thrusts and Programs.....	32
5.3.3 Staffing Plan.....	39
5.3.4 Equipment Plan	39
5.3.5 Operation Plan.....	42
5.3.6 Socioeconomic Effects of Packaging Technology Center Development.....	45

Executive Summary

1 Requirements for Upgrading Packaging

1.1 Areas of Improvement for the Packaging Sector

Required to solve problems faced by the industries using packaging:

- 1) Elimination of damage to products shipped from Singapore caused by packages that do not have suitable designs for shipping and handling conditions
- 2) Development of capability and facilities to perform packaging design in compliance with strict environmental legislation.
- 3) Improvement of packaging materials of insufficient quality, procured/used that hitherto showed lack of consideration of meteorological conditions in Singapore
- 4) Improvement of packaging materials which do not meet quality requirements because of insufficient production technology and quality control practices
- 5) Elimination of insufficient packaging caused by improper packaging processes
- 6) Development of capability for assisting packaging design, and providing quality packaging materials and packaging operations, which are required to develop the contract packaging ability needed for Singapore to function well as a regional distribution center

Required to support future advancement of industries:

- 1) Development of ability to design packaging specifically for transportation of more sensitive and valuable products
- 2) Improvement of capability to produce more precisely designed packaging materials
- 3) Improvement of ability to develop packaging materials which meet increasingly diverse demand
- 4) Improvement of graphic design and technology for printing on packages
- 5) Development of ability to improve packaging in consideration of distribution efficiency

1.2 Requirements for upgrading packaging

Areas of improvement related to packaging design

Many package-related issues seen at present can not be fully solved through individual corrective measures alone. Rather, it is important (a) to collect basic technical data through analyses of strength characteristics of products to be packaged, shipping

conditions, and strength of packaged goods, and (b) to improve the export packaging design ability, so that improvement of packaging can be made systematically.

Areas of improvement related to packaging materials manufacturing

- a) Quality improvement of packaging materials supplied to industries in Singapore
- b) Development of the ability to provide appropriate technical information to the packaging users

Areas of improvement related to the packaging process

- a) Dissemination of suitable packaging process technology
- b) Promotion of mechanization of the packaging process

Necessity to address environmental issues

2 Packaging Technology Center Development Plan

2.1 Development Thrusts and Programs

Thrust 1: Giving support to upgrading industries in Singapore through promotion of the advanced packaging sector

Traditionally, the packaging sector in Singapore has been coping with packaging-related issues on a case-by-case basis, with individual companies having almost no section nor staff specialized in packaging. The existing packaging sector is not capable, therefore, of meeting the increasingly sophisticated and diverse packaging requirements now evident and expected in the future, particularly those of the electronics/electrical products industry.

The advanced packaging sector is expected to have the ability to analyze and solve problems in a systematic manner by staff specialized in packaging and having appropriate packaging technology, and to develop new packaging in a time- and cost-effective manner. Such an ability can not be learned only through seminars and training courses, but should be acquired through participation in actual research and development projects or studies on packaging damages.

These R&D projects and studies will also provide good opportunities for the packaging sector to develop new expertise.

The Packaging Technology Center can play a core role in introducing packaging technology into Singapore, transferring it to the sector and accumulating experience and expertise in this country.

Program 1: Accumulation of packaging technology at the Center

- 1) Introduction and acquisition of advanced packaging technologies and skills by the Center's staff, and the formulation of curriculum for technology transfer programs

- 2) Inviting packaging experts from other countries which have advanced packaging technology, and/or ties-up with packaging technology centers in these countries for technology acquisition

Program 2: Transfer of packaging technologies to the packaging sector through joint research with industries

To conduct joint research and development projects with related industries. At each stage of projects, relevant packaging technology and research methodology will be transferred to the participants.

Program 3: Collection and accumulation of data and development of a database related to transportation packaging through joint and own research projects

To collect and accumulate data required for transport packaging design, which are obtained through joint and own research projects, in a systematic manner. The data will be indexed and sorted out to develop a database accessible by those who need the data.

Program 4: Development of packaging technologies reflecting packaging environment in Singapore through own research efforts

The Packaging Technology Center will undertake its own research focusing on matters related to the improvement of packaging, which are not likely to be taken up in contract research or joint research, and make the results public.

Program 5: Collection and dissemination of packaging technology information from overseas

To collect and disseminate overseas packaging technology information to the related industries, thereby providing a "technological stimulus" to the packaging sector. At the same time, information so collected will be made into a database available to the packaging sector.

Program 6: Organizing associations for the study of packaging technology

To organize associations for the study of packaging technology with participation by experts from packaging makers and users, distributors and related industries, and other academic and government organizations, for the purpose of technology exchange and mutual learning to upgrade technical expertise of packaging personnel and to encourage and revitalize corporate R&D activities. The associations will serve as the core of the packaging sector in technology exchange and mutual learning.

Program 7: Stepping up of efforts to deal with environmental issues

To initiate a systematic approach to comply with environmental regulations in export markets, thereby not only assisting Singapore's manufacturing industry in effectively dealing with the issues, but also making an advancement in the attitude for environmental protection as one of the competitive edges of Singapore's products.

Thrust 2: Provision of technical infrastructure for packaging development

Actual development of packaging technology is conducted by individual companies. To help produce effective results from efforts of individual companies, a variety of technical infrastructures are called for, including industrial standards as norms for product development and quality control, means and tools to evaluate development results, technical assistance in product development, and means to foster human resources for packaging development. The Center will develop and provide these technical infrastructure to support individual companies and promote the upgrading of the packaging sector.

Program 8: Support for technological development of the packaging sector

- 1) To conduct tests on packaging materials and quality on a contract basis;
- 2) To provide consulting service for improvement of packaging, based on the test results; and
- 3) To supply experts for technical assistance upon request from clients.

Program 9: Promotion of standardization in packaging

- 1) To conduct research projects required for development of packaging--related standards;
- 2) To provide Technical Committee on Standards or the industry with technical advice on preparation and revision of draft standards ; and
- 3) To promote use of standards among the relevant industries.

Program 10: Development of standards testing system for packaging

Undertaking of the third party tests are one of SISIR's important functions, and the SISIR is expected to have facilities and equipment capable of handling most of tests based not only on Singapore Standards but also on foreign and international standards.

Program 11: Human resource development

- 1) To conduct training courses to develop expertise in packaging technology; and

- 2) To provide manpower to assist the industry in developing human resources.

Thrust 3: Evolution to Southeast/Southwest Asian Packaging Centers

At present, packaging technology in Southeast and Southwest Asian countries is still at a relatively low level, and many countries have strong interest in improving packaging quality. On the other hand, many MNCs operating in these countries have testing equipment for a limited number of test items only, and do not have the ability to conduct a complete range of packaging tests. Under these circumstances, there is a clear need and opportunity for the Packaging Technology Center in Singapore to serve as a regional center offering testing and other services.

If the center can fulfill such a function, it will lead to an improved reputation for the packaging sector in Singapore, and then its industrial products. And the increased reliability on the packaging sector in Singapore will create the opportunity for the sector to earn income by providing services to countries in the region.

Program 12: Evolution to a packaging engineer training center for Southeast and Southwest Asian Regions

To conduct training courses for packaging engineers in Southeast and Southwest Asia regions

Program 13: Evolution to a integrated packaging testing center for Southeast and Southwest Asia Regions

To conduct standard tests on packaging on contract basis for users in Southeast and Southwest Asian countries, and to receive trainees on package testing techniques.

2.2 Staffing Plan

Manager	1
Senior staff	2
Staff (Engineer)	3
Assistant staff	3
Secretary	1

2.3 Equipment Plan

In completing the Center's equipment and facilities, it is recommended that the first priority be placed on those for transportation testing, while the services for food packaging are to be carried out making use of the existing facilities in other centers in SISIR. The

service programs and required equipment and facilities for food packaging should be examined after completing those relating to transportation packaging. Of the services related to transportation packaging, the testing services for quality of packaging materials is recommended to be carried out using the equipment owned by other centers. Also, the testing services for transportation of dangerous goods should be undertaken using the existing equipment of other centers, if necessary.

As for the equipment and facility relating to transport packaging, the existing equipment (as of March, 1993) will enable the Center to carry out most items of standards testing and contract testing. However, for the more sophisticated and systematic packaging tests and research works, the existing equipment will be insufficient. In view of upgrading the Center to meet the needs of the packaging user industries, which will become increasingly sophisticated, installation of additional equipment is recommended. The most important equipment and facilities to be added include (1) a shock testing system, (2) a drop dynamic testing machine for package cushioning materials, and (3) a light vibration table used for up to 500 Hz.

2.4 Issues Related to Operation/Management

Projected revenue and expenses

(Unit: S dollar)				
Year of Operation	2nd	4th	6th	8th
Revenue				
Fees for contract testing	125,000	176,000	250,000	352,000
Fee for contract researches	205,000	282,000	410,000	563,000
Entry fee for joint researches	54,000	54,000	107,000	107,000
Entry fee for short-term seminars	49,000	68,000	93,000	129,000
Entry fee for training courses	0	86,000	118,000	161,000
Membership fee for research association	18,000	38,000	40,000	41,000
Contract testing fee from overseas clients	13,000	35,000	47,000	62,000
Total revenue (a)	464,000	739,000	1,065,000	1,415,000
Operation cost				
Direct Labor Cost	204,000	378,000	378,000	378,000
Overhead Cost	306,000	567,000	567,000	567,000
Maintenance Cost	10,000	31,000	51,000	62,000
Other Operation Costs	20,400	48,400	80,600	80,600
Operation Cost Total (b)	540,400	1,024,400	1,076,600	1,087,600
Balance [(a)-(b)]	-76,400	-285,400	-11,600	327,400
(Depreciation)	411,000	411,000	0	0

The above financial projection assumes only the equipment required urgently will be added to the existing equipment and covers costs of staff proper to the testing and research services alone, excluding other parts of staff costs (costs for a half of that of the manager, a staff, an assistant staff, and a half of that of the secretary), which are related to SISIR's functions for promotion of standardization, dissemination of technology information, etc., and are to be compensated by the government budget.

The projection also assumes the additional revenues from (1) member fee from organizing study associations relating to packaging technology, and (2) receiving orders from overseas clients.

According to the financial projection, the balance will turn to be positive in the seventh year at single fiscal year basis, with the accumulated balance becoming positive at the ninth year. Nevertheless, it will be difficult to cover depreciation. Under such a situation, to upgrade the function of the Center further, and to maintain the existing equipment with appropriate renewal, thereof the support of the government should also be considered particularly in financing. Such financing support of the government may be justified in view of the social and economic effects anticipated from establishment and activity of the Center.

Role of the Packaging Technology Center for the packaging sector development

The individual companies, instead of the public organizations including the Center, are assumed to play the leading role in development of the packaging sector. The Center will provide only (1) support to the packaging sector in developing its own technological infrastructure, and (2) supplemental assistance to related industries and individual companies who are limited in ability or resources to conduct required activities.

Demarcation of functions with other public technical organizations

(1) Promotion of automation of the packaging process

Development of hardware required for automation of the packaging process is in rapid progress in various countries. Yet, the packaging industry in Singapore seems to be reluctant to introduce automation, despite the fact that they are facing rising labor costs and a shortage of labor supply. This is because they do not have know-how as to how the automation process be established in light of the particular conditions of Singapore, and how to integrate the packaging design and packaging management with automated packaging processes. Packaging Technology Center should focus its efforts on guidance and support in these areas, while Automation Applications Center (AAC) provides technical support in hardware aspects.

(2) Human resource development

Packaging Technology Center is recommended to emphasize human resource development through training for company management and design engineers, who are actually engaged in packaging design and manufacturing. The training should be done in keeping with the mission of SISIR to take leadership in advanced technology and quality. At the same time, the development of training programs and curricula and the provision of necessary human resources for training should be emphasized from the point of view of proliferating the results of research and development efforts to related industries and future generations.

Once the Center establishes methodology of technical guidance through its involvement in various development researches, it can transfer the function of technical guidance to polytechnics and other organizations. At that stage, the Center's technical guidance should be shifted to those which involve packaging development.

Demarcation of functions with other technology centers of SISIR

(1) Transportation packaging

Research on transportation packaging must be conducted so that the packaging be optimized over the entire packaging process and the physical distribution process. This requires collecting of required data in a systematic manner. For this purpose, Packaging Technology Center needs to have a complete set of testing equipment, regardless of equipment owned by other centers.

The research and tests on corrugated board and cartons, which is one of the most important packaging materials for transport, is recommended to be undertaken by the Packaging Technology Center, rather than the Paper and Board Testing Laboratory, because an evaluation is needed from the standpoint of transportation packaging.

At the same time, the tests, standardization and technical extension services related to transportation of dangerous goods should be one of the functions of the Packaging Technology Center, and are to be handled in a comprehensive manner in view of the nature of transportation packaging.

(2) Consumer packaging

Packaging Technology Center should be responsible for evaluation, related research and development, and technical guidance, on the conditions of containers, while Food Technology Center will examine the indirect effects of containers on contents. In addition, the direct effects of containers on contents are to be jointly handled by the two centers; the former is primarily responsible for containers, and the latter for constituents

of containers in food. The two centers should be jointly responsible for determining alternative characteristics for quality verification of food packaging, though Food Technology Center alone should perform analysis and evaluation so as to avoid duplication of equipment and staff.

In the case of issues related to environmental compliance, those related directly to packaging materials, such as development of environment-friendly materials, etc., activities should be led by Polymer Technology Center. Packaging Technology Center should be responsible for such functions as developing environmental compliance systems and establishing evaluation standards for environment friendly packaging materials.

Packaging Technology Center should have the function of issuing certificates as the proper third party organization.

Other Issues Related to Management

(1) Need for strengthening relations with related industries

1) Effective communication

To ensure that the intent of the packaging sector is reflected in the Center's activity, it is important for the center to have a place of regular communication with representatives of the packaging sector.

2) Associations for the study of packaging technology bridging the center and related industries

Needless to say, the center's activity has to address needs of related industries, and its research projects should be conducted with close collaboration of related industries to reflect the current state and problems facing them. Also, the outcome of research projects should be provided to the industry side so as to be utilized by the latter. The study associations devoted to packaging technology can play a central role in meeting the above demand.

(2) Level of service fees and improvement of government subsidy system

While service fees of SISIR set at market price are affordable for MNCs and their joint venture companies, they are likely to be very costly for local SMEs.

At present, the local SMEs which use SISIR's service are eligible for a government subsidy which covers 50% of the actual fee. However, there are many complaints about complicated application procedures and the relatively long period of time required for processing. To be able to set the service fees at a market price level to make the

operation of the Center viable, the government subsidy program should be reviewed and improved to maximize its use by eligible enterprises.

(3) Need for completing testing equipment

The plan assumes that testing for food packaging will be undertaken as a joint service with and using the equipment of the Food Technology Center, if available. As for the testing equipment and facilities relating to transport packaging, however, further efforts for installation of additional equipment and facilities are recommended to provide the packaging users with the more sophisticated technical services required for their advancement, in addition to the services in the basic testing fields currently available. The most important equipment and facilities among others include, (1) a shock testing system, (2) a drop dynamic testing machine for package cushioning materials, and (3) a light vibration table use for up to 500 Hz.

(4) Maintenance and upgrading of equipment

Equipment maintenance needs to be carefully planned to ensure smooth operation of the center, including adequate maintenance by contract and proper budgeting. Also, equipment should be upgraded in a timely manner to provide the highest practicable level of service all the time, by addressing changing industry's needs and technological requirements.

(5) Alliance with counterparts in countries having advanced packaging technology

Such basic activities of the Center as standards compliance test, and certain contract test, may be performed by its staff with the planned recruitment and the training programs. However, to keep abreast of rapidly advancing packaging technology, and to provide appropriate technical guidance and technical information services required in accordance with the sophistication of the industries, the Center is recommended to make the most of the support available from the similar organizations in countries with advanced packaging technology, through teaming up with these organizations, particularly until the packaging sector in Singapore can develop its ability to be the counterparty of the Center in developing packaging technology in this country.

1 Background, Objectives and Scope of the Study

1.1 Background and Objectives

From its historical position as an 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 further development of the manufacturing industries in the fields of production and distribution.

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.

In order to nurture and promote the domestic packaging sector the government of Singapore established the Packaging Center within the Singapore Institute of Standards and Industrial Research (SISIR). 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 Japan International Cooperation Agency (JICA) 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

The Scope of Work for the Study was defined as follows according to the S/W agreed and signed on June 24.

- 1) Macroeconomic overview
- 2) Confirmation of policy background

- 3) **Assessment of local packaging industries**
- 4) **Analysis of user industries' demand for packaging**
- 5) **Review of present status of SISIR in general and the Packaging Center in particular**
- 6) **Formulation of the development plan of the Packaging Center in SISIR**
- 7) **Conclusion and recommendations**

2. Industrial Development in Singapore

Singapore, a city-state with an area of more than 600 square kilometers, endowed with an excellent natural harbor and enjoying a favorable location for international transportation, has demonstrated an amazing development record, in tandem with the economic development of the adjacent countries, and has been recognized as one of the Asian NIEs. By adding to the earlier financial center functions, it acquired the functions of a physical distribution center for the region, as well as a production base in the region for multinational corporations' (MNCs) international operations.

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 subsectors.

Recession in 1985 and changeover in industrial development policy

The annual growth rate of the GDP of Singapore averaged 8.4% for the period of 1960 through 1990. In the 1980s, however, it experienced a negative growth rate, in both 1985 and 1986. Analysis of the factors behind this recession are of great importance when considering the path Singapore's industrialization will take from this point onward.

The first is the trend for output of the manufacturing sector to decline. It would appear that the decline in the economic growth of the national 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. Investment in manufacturing had also declined since 1982.

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

The third is the fact that the policies during the 1980s, favoring high wages and high value added, 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 in infrastructure, in particular housing, which was created as a result of the promotion of high savings. The resultant excessive investment led to oversupply and idle resources.

Direction of industrial development

The Singapore government reassessed its industrial development policy in response to the recession. The Strategic Economic Plan 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).

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 limitations of the domestic market size and the supply ability of manpower on the other.

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 will be 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 activity together with related commercial and service subsectors, and peripheral industries.

The Plan anticipates that the service sector and not the manufacturing sector is to be the leading sector for economic development during the coming decade.

In the services sector, apart from the existing marine transport, air transport and telecommunications subsectors, there are expectations for foreign investment in business 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, communication equipment and information technology, bio-industry, pharmaceuticals and optics, and efforts must be devoted to growing subsectors that have

high profit potential, and to promoting establishment in Singapore of regional headquarters in addition to regional production bases, of MNCs.

Promotion of SMEs

There was a shift in viewpoint for industrial development in the Strategic Economic Plan, from the former foreign capital-led industrialization (or, industrialization centered on foreign capital) to higher importance for local industry.

The government of Singapore is committed to promoting and developing the small and medium enterprises (SMEs) and has drawn up a Master Plan to support this sector of the economy. Moreover, one of the major aims of the Master Plan is to re-structure the economy of Singapore. And, 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 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 to assure Singapore of strong basic service industries and supporting industries which will permit cooperation with MNCs, and contribute to establishing Singapore's position in the world economy. The local SMEs constitute an important and large part of Singapore's economy. They account for about 90% of all firms, 44% of employment, 24% of the value added and 16% of direct exports in the manufacturing, commerce and service sectors taken together. The past measures of promoting the growth of SMEs, carried out with preferential treatment given to foreign investment, were not necessarily successful. 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 in export markets. Further many of the local SMEs have not yet reached levels of product quality and technical expertise which can be expected by the foreign affiliates, and this fact explains the low level of domestic procurement by foreign affiliated firms.

Role of packaging industry

In order to maintain the industrial development process, it is necessary to selectively support those sectors which can best make use of the advantages in available technology, transportation, communication and financial services so that these sectors enhance Singapore's attractiveness over nearby competing 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 an industry for which upgrading and strengthening is expected to lead to promoting a new service-export sector on its own.

3 Present Conditions and Development Issues of the Packaging Industry in Singapore

3.1 Overview

Scale of the Industry and the market

In Singapore, 187 companies were engaged in production of packaging materials, and the in total employment of 9,200 persons gives an average number of employees per company of 50, while the total value of production was about S\$1.5 billion. This value corresponds to 2.3% of Singapore's GNP. Of the production value of S\$1.5 billion, 72% or S\$1.07 billion is shipped to domestic users, and the remaining S\$400 million (28%) is exported to nearby countries. An tripling of exports was recorded for this category during the period of 1978 through 1988. If S\$700 million worth of packaging, which was exported indirectly with exports of industrial products, is included, the total value of packaging exports amounts to about S\$1.1 billion, or about 73% of packaging materials production value.

Factors affecting domestic supply of packaging materials

The current condition of factors affecting the domestic supply of packaging materials and their supply situation in Singapore is as follows:

Packaging Materials	Supply Conditions		Characteristics of Production and Constraints on Production in Singapore		
	Procurement Method	Supply Source	Production Lot	Production Technology	Raw Material Availability
Paper Bags, Sacks (Light Duty)	Order-made	Domestic production	Suitable	Suitable	Suitable
(Heavy Duty)	Order-made	Domestic production	Suitable	Suitable	Suitable
Cartons	Order-made	Domestic production	Suitable	Suitable	Suitable
Liquid Cartons (For LL)	Order-made	Imported	Not suitable	Not suitable	Suitable
(Ordinary Use)	Order-made	Some imports	Not suitable	Suitable	Suitable
Corrugated Cartons	Order-made	Domestic production	Suitable	Suitable	Suitable
Glass Bottles	General-purpose	Imported	Not suitable	Suitable	Suitable
PET Bottles	Order-made	Imported	Suitable	Not suitable	Suitable
EVOH Film	Order-made	Imported	Suitable	Suitable	Not suitable
Laminated Film	Order-made	Some imports	Partly unsuitable	Partly unsuitable	Partly unsuitable
	General-purpose	Some imports	Suitable	Partly unsuitable	Partly unsuitable
Metal Cans	General-purpose	Domestic production	Not suitable	Suitable	Suitable
Plastic Bags	General-purpose	Domestic production	Not suitable	Suitable	Suitable

If a lot to be ordered by a packaging user is smaller than the minimum economical production lot in view of production and cost efficiency, the user must be content with using general-purpose packaging materials that are available in the market. These packaging materials are generally limited with respect to the available varieties of material composition and their shape, and tend to increase packaging cost. Many packaging users, however, are forced to use such materials in Singapore.

3.2 Paper and Board Container Sector

The number of companies in the paper and board container sector is 62. They have a value of production of about S\$600 million, and account for about 40% of the total production value of the packaging industry. More than 60% of the shipments on a value base is to domestic destinations, and the remaining share of about 40% is exported to the ASEAN and other Southwest Asian countries.

The scale of user industries of these containers is in general small, and the number of products that are produced in large enough quantities to justify use of high-speed container manufacturing equipment is few. Therefore, generally, low-speed equipment is employed. As a result, labor cost accounts for significant portion of the production cost, and there is a limit what can be done to reduce production costs. Moreover, because such arrangements can not cope with the demands of mass production, a restraint is imposed on expansion of the market.

Corrugated board and corrugated cartons

There are 36 companies in this sector, and many of these are integrated producers, that make both corrugated board and cartons. There are six large and 30 small and medium size companies. Great differences exist between the two groups regarding production facilities, technology, quality control, and other matters, including the user groups served. The larger companies supply electric and electronic product manufacturers, and the foodstuff MNCs, and possess automated equipment that produces large lots. These companies give attention to quality control, inventory management, as well as computerized inspection equipment for their production lines. In contrast to that, the small and medium scale companies have as users of their products local food companies, apparel makers and the like, and accept orders for lots of 20-30. They are mostly equipped only with printing equipment and box-making equipment of an old type. Often they have no inspection equipment or, if they have any, it is manually operated.

Paper containers and boxes

There are more than 50 makers, and of these, more than 20 are engaged solely in printing of boxes.

Generally orders for paper boxes are for small lots that must be produced and delivered in a short period of time, and users' requirements are extremely diversified. Because of this it is necessary for box makers to maintain systematic control over pre-production work including graphic design, and the diversified production processes, and product inventory which requires relatively large warehouse space. However, for Singapore, where there are a relatively large number of smaller-scale enterprises, the investment needed for this is burdensome and can not be easily accepted, so that users are not always satisfied. As a result, as can be seen among the MNCs in food manufacturing sector, there are some instances of procurement of boxes from the home country.

Other paper and board containers

There are 20 makers of paper bags, and in addition, more than 200 companies are engaged in printing. Many of their products are used by tourists visiting Singapore, to take home purchases made there. Some high-speed machines have been used in Singapore, but in most cases, considering that the market scale in Singapore is on the order of 150,000 bags a month, it would be necessary to export to justify additional investment in equipment.

There are five makers of heavy-duty sacks and three fiber drum or tube makers. Each of the three companies has acquired its technology from the US or Japan.

Issues in the paper and board container sector

Current issues in the paper and board container sector are primarily concerned with corrugated cartons.

- (1) Issues related to quality improvement of packaging materials
 - 1) Preventing corrugated cartons from buckling caused by absorption of moisture, and vibration
 - 2) Improvement of the quality of corrugated board
 - 3) Upgrading of technologies of printing on corrugated board
- (2) Joint development efforts with user industries to improve the quality of packaging materials
 - 1) Joint efforts for reduction of transportation cost by improving shock absorptive materials
 - 2) Study of container specifications optimum for diversified modes of distribution
- (3) Taking measures for environment conservation

- 1) Diffusion of production technology meeting requirements of recycling
- 2) Measures responding to environmental regulation in importer countries

3.3 Metal Container Sector

There are 23 metal container makers, with a manufacturing output of S\$440 million, and which account for 30% of the total value of production of the packaging industry.

More than 80% of cans for packaging food is destined to the domestic market, the remainder being exported to nearby countries. In contrast to this, as much as 96% of the non-food metal containers produced is for the domestic market and almost all is shipped directly to users.

Metal containers

In a recent five-year period, demand for metal containers grew constantly, reflecting the increase in exports of foods and beverages produced in Singapore.

There are twelve makers of metal containers, who make a variety of decorated cans, or export printed can metal sheets or can parts. There are two large companies in the sector, manufacturing all kinds of metal container. One of them also makes aluminum cans for beer and soft drinks.

Metal container makers in Singapore have acquired ability to use technological advances, from their parent companies or others overseas, and the industry has few technological problems. Problems related to metal containers are in many cases caused by quality control problems at the user, or the food packer.

Drums and pail cans

There are four makers of metal drums, and five of pail cans. Metal sheet for making these drums and cans is imported on the order of 50,000 tons/year.

Almost all of these companies originally were users of cans, for edible oil, lubricant, paints and ink. Even at present they consume a large share of their own production, and some of them do not sell their products to other users. Up to 96% of the production is for domestic shipment of which more than 87% of total production is shipped directly to the users. Since the demand for drums and pail cans in adjacent countries is high, and domestic demand is also very strong, there are ten companies that handle recycled drums and pail cans.

The technology for manufacturing drums and pail cans is well established, and each producer has a technical agreement with foreign companies for special linings using specialty plastics.

Issues in the metal container sector

- (1) Upgrading of technical capability through working with packaging users for troubleshooting

The process of sealing food cans, which is the major product of the metal container sector, is performed by the food manufacturers. When a technical problem is identified, therefore, its cause is recommended to be determined through efforts by both the can maker and the user.

- (2) Measures for environmental protection

The recovery rate of metal containers in Singapore, 60%, is the highest in the world. However, only steel cans are now in circulation. It is necessary to establish, in advance of diversification to aluminum, a means of separate collection of steel cans and aluminum cans prior to recycling.

It is also necessary to print appropriate indications on cans that are exported, according to the requirement in the destination countries regarding disposal and recycling of the can.

3.4 Plastic Container Sector

The number of companies engaged in plastic processing is 285, and of them, 86, are seen as being producers of packaging materials. The value of production by the latter is about S\$410 million, and accounts for about 30% of that of the packaging industry total, and is equal to that of the metal container sector.

Film bags

There are at present more than 50 companies in Singapore making plastic film or bags made from film, and they consume more than 50,000 tons a year of polyethylene, polypropylene and polyvinyl chloride.

Film bags made are either for shopping or industrial use, and most production in Singapore at present is of high-density polyethylene bags for shopping use. There are no technical requirements made of these bags other than they have a certain minimum strength. There are almost no special technical problems. More than half of production is exported to adjacent countries.

Other films

In Singapore there are seven companies engaged in making this kind of film. Both of two types of processing methods, dry lamination, and extrusion lamination, are in use.

Demand for such special purpose films as stretch film, shrink film, and anti-static film is increasing in Singapore, but there is little domestic production and mostly it is met by imports. Demand for anti-static protective packs is particularly increasing owing to the growth of electronics production, especially of printed circuit boards.

Molded containers

There are now more than ten blow-molding companies in business, manufacturing bottles for liquid products and using polyethylene, polyvinyl chloride, PET etc. Product defects are seen for these packaging products, caused by improper technology in the molding process, such as pinholes, cracks or unevenness at the aperture, which lead to leakage of the liquid contents.

There are more than 30 injection-molding companies, and about 10 vacuum-formed container companies. In the case of plastic trays for foods, to avoid reducing display effects of the packaged food at retail shops like supermarkets, it is necessary to put partitions or a small protuberance in the tray (without increasing costs), but this practice is not established in Singapore.

Foamed shock absorbent material

More than 30 companies make foamed shock absorbent packaging materials. They manufacture the materials from expanded polystyrene (EPS), polyethylene (EPE) and polyurethane foam. They also make air cap sheets by bonding low-density polyethylene film so as to leave air bubbles between the two layers.

In designing shock absorbing materials it is necessary to determine the optimal absorbency conditions for the product to be protected, by giving consideration to the specific protection and absorbent requirements of it. However, there has been almost no collection of required data so far in Singapore.

Issues in the plastic container sector

Since it was relatively easy for plastic container manufacturers to acquire equipment and raw materials, little effort was made at technological aspects of R&D, and establishment of processing technology has been retarded. The main issues are related to this and are:

- (1) Improvement of packaging material quality
 - 1) Improvement of plastic film printability
 - 2) Prevention of delamination
 - 3) Elimination of pinholes and cracks in blow-molded containers
 - 4) Elimination of leakage caused by uneven aperture of blow-molded containers

- (2) Cooperation with the packaging users, for solving their technical problems caused by lack of appropriate technology such as heat seal technology
- (3) Research on new, optimal application of materials, and diffusion of technologies on packaging work
 - 1) Development of technology on packaging materials for retort processing
 - 2) R&D of laminating technology on multi-ply film
 - 3) Diffusion of technology for making compartments and partitions on vacuum-formed trays
 - 4) Collection of data on shock absorbance performance of foamed cushioning materials
- (4) Measures for environmental protection

3.5 Wooden Container Sector

Sixteen companies are engaged in fabricating wooden containers. The total value of their production is S\$50 million, merely 3% of the packaging industry's total.

Many of these companies are in the lumber business and handle Malaysian lumber, and/or are makers of plywood and building materials, and also make wooden boxes, pallets and crates.

85% of their shipment is consumed domestically. In keeping with the increase in containerization, there has been a steady decline in demand for wooden crates and boxes for packaging. Makers of wooden boxes possess machinery specially made for cutting wood, curing it, fabricating plywood, making pallets, and so on. Fabrication of boxes, however, is almost entirely a manual job.

Issues in the wooden container sector

The major issues in this sector are related to pallets:

- (1) Standardization of pallet specifications
- (2) Reduction of moisture content of pallets

4 Packaging-Related Issues Facing Major Industrial Users

Major user industries of packaging materials in Singapore are food and beverage, electronics/electrical, and chemicals and pharmaceuticals. These three industry groups account for 82.3% of total value of packaging materials consumed by all the manufacturing industries, with each share being 40.0%, 22.1%, and 20.2% respectively.

4.1 Electronic and Electrical Industry

Packaging in the electronics/electrical industry gives importance to transportation packaging to protect products in transportation, because (1) electronic and electrical products and parts are susceptible to damage during transportation, (2) they are valuable commodities and incur large amounts of damage if they are physically damaged in transportation, and (3) they are seldom displayed in packages at storefronts. As these characteristics are not likely to change in the future, transportation packaging will continue to be a major part of packaging for electronic/electrical products and parts.

The production development of electronics equipment and components in the developing countries shows the following particularities.

- 1) Increasing importance given to using these production sites in the developing countries as export bases, with active promotion of production transfer to these countries, particularly of technically stable production.
- 2) Expansion of local components production enhancing production by indigenous local industry, in addition to the enhancement of in-house production by the foreign equipment manufacturers in the developing countries and production by the foreign components manufacturers locally.
- 3) Expansion of component imports 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 industrialized countries.

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.

The value added by the electronic and electrical industry in Singapore represents one third of that by all the manufacturing industries, and commands an important position in

the country's economy. Today, the electronics industry, however, is facing rising 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 a shift to production of advanced electronic equipment and components – a far-reaching goal for neighboring countries.

In the process of industrialization including that of electronics industry, Singapore has been successfully attracting a number of multinational corporations. While their operations require a pool of suppliers to support their production activities, the electronics industry in Singapore has met the requirement partly by procuring from foreign suppliers who have also established their production facilities in Singapore, and mostly by importing required components and subassemblies. Indigenous local companies generally lack the technical ability to satisfy requirements of the world-class manufacturers, and thus have so far played a very small role in development of the supporting industry.

For further advancement of the electronics industry, the enhancement of R&D activities is indispensable. The enhancement of R&D requires establishment of industries who can provide a variety of small-lot processing and production services. In this connection, the present pool of foreign-affiliated suppliers is not enough to meet the demand, and the promotion of local industries is essential.

Now, MNCs are increasingly adopting a new strategy to limit production in industrial countries to products and parts which need to be on hand for quick response to any changes in their markets, or which are technically difficult to be transferred to overseas production bases. Under such a new strategy, Singapore is positioned as a production base for more advanced products and parts which are to be shipped to neighboring countries for final assembly. So far, products and parts manufactured in Singapore have been limited to those which production technology has been established in industrial countries. In the future, however, new products and parts which have not been produced even in the industrial countries, will be increasingly manufactured in Singapore.

The prospect for such changes call for a variety of improvements in the industry to satisfy packaging requirements. First of all, the packaging sector related to electronics and electrical products must acquire the ability to provide sufficient protection in transportation packaging for increasingly sophisticated and valuable products. Secondly, as production of new products will be carried out in Singapore without prior operation in the industrialized countries, packaging for these products need to be designed locally, with ready supply of packaging materials. Thirdly, since most of products and parts produced

in Singapore will be exported, the packaging sector needs to have appropriate technology on export packaging which should take into account conditions peculiar to each export market and its distribution system.

Today, consumers are demanding diverse electronic and electrical products and shorter times to market, and the distribution systems for products and parts are changing accordingly, by creation of flexible production and distribution capabilities to supply a wide variety of products in small quantities. Packaging design, therefore, needs to address such changes, with a particular emphasis on the ease of handling and the reduction of distribution costs. Since Singapore functions as a physical distribution center for electric/electrical products and components among industrialized countries and adjacent countries, and thus, the system for physical distribution is quite sophisticated, the impact of streamlining of the system is expected to be significant.

Further, the electronics and electrical industry, which consumes large amounts of packaging materials, is expected to play a critical role, together with the food industry, in dealing with global environmental problems. Today, it is high time for the industry's packaging sector to develop the ability to address environmental issues on a global scale.

Requirements for upgrading packaging

(1) Improvement of packaging technology

1) Lack of appropriate packaging management arrangements

The status of packaging management and organization in electric and electronic products manufacturing companies, and the locus of responsibility for it and corresponding authority, are generally not clear, and as a result there is a tendency for packaging technology, equipment, effectiveness of managerial control and maintenance to be deficient.

2) Lack of appropriate approach to optimum packaging design

Often the development of packaging design is done by a local packaging company's making of a prototype, that is subjected to the requisite strength tests, and the prototype is changed until it passes the tests. This trial and error approach is a waste of time and money. Further, because shipment is then done without there being assurance from a theoretical approach, it is not possible to make a well-founded revision of the design when there is an accident to cartons after the goods have been shipped in them to the market.

3) Lack of systematic approach for integrated optimization of the production and packaging costs

Transport packaging for electric and electronic products bear a close relationship not only to the strength of the products, their form, dimensions and weight, but also the

environmental conditions during storing and transporting the goods. Therefore, when the product is designed, it is necessary to seek optimization by an overall approach that takes both product and package into consideration so that it has adequate strength not only for use but also for withstanding the environment during its distribution phase.

(2) Ensuring the required facility and equipment, and human resources/technology for packaging

To attain the optimum packaging design, it is necessary to have the proper equipment and knowledgeable, trained personnel so that a design approach grounded in theory may be used. The local companies have only limited equipment, and few specialists in packaging, though parent firms of some large firms may have such equipment and personnel.

(3) Promotion of standardization

1) Standardization of pallets for increased use of unit load transportation system

In order to improve efficiency in exporting to a large number of destinations, greater use of door to door, integrated multi-mode international transport is necessary. In order to secure the advantages stemmed from use of this system, however, packaging specifications used must suit the integrated transport system. Thus, in order for there to be greater diffusion of use of unit loads, need exists for cooperation of companies in the distributive area, to promote use of pallets that conform to international standards.

2) Standardization of packaging quality and testing methods of packaging materials for improvement of packaging reliability

In order to improve the reliability of Singapore's electric and electronic products and their packaging in the international market, rather than rely on design and test standards that are adopted by each company individually, as is now the case, it is necessary to develop Singapore standards; and on that basis companies may determine their own standards.

(4) Environmental considerations

Measures related to the disposal and use of waste packaging materials are being given international attention as a global issue. Under such situation, it is important to take necessary measures in the context of complying with international movements, which will be also useful for maintaining the international competitiveness of Singapore products. In this light, necessity exists for environmental affairs activities within each company to be improved, with support from the industry as a whole.

4.2 Food and Beverage Industry

Packaging in the food and beverage industry focuses on consumer packaging, rather than transportation packaging, because of the following characteristics related to food products:

- 1) Most products are low-cost commodities, so that it is economical to allow a certain degree of damage in transit, rather than to accept a high cost to make transportation packaging complete.
- 2) Protection of products from deterioration after manufacturing is significantly important in maintaining the product value and expanding the markets.
- 3) Food products are displayed in packages at storefront, and consumers choose them based on information indicated on package.

The food products industry in Singapore is the second largest industry in production scale, after the electric and electronic industry, with a total output including beverage industry of S\$2.5 billion (about 200 billion yen). Exports amount to about 55% of output in the case of food industry, and 30% for beverage industry. The share of exports in food production has not shown great change over a long period of time, but in the case of beverages the share has increased together with the increase in production, indicating that the beverage manufacturers interested in exports have shown rapid growth.

The food industry in Singapore consists of three distinguishable subsectors.

The largest subsector consists of local food suppliers serving traditional food markets, both domestic and overseas. Products include sauces, seasonings, and spices for ethnic foods including Chinese, Malayan, and Nonya, and Chinese frozen foods, snacks including preserved fruits and ethnic cakes, noodles, and ethnic drinks. Characteristically, all of them are sold through distribution channels peculiar to Chinese foods, even in export markets.

The second subsector supplies general foods, including oil/fat and dairy products, but the destination of their products is markets of Malaysia, the Middle East, and Brunei, which have consumer characteristics different from other markets. The subsector mainly consists of local enterprises, with some foreign-affiliated companies from other NIEs.

The third subsector is comprised of (1) foreign companies and (2) local enterprises under OEM contract or license agreement with food companies in industrial countries; both supply general foods for international markets. The products include frozen foods and fishery products of export grade, chocolates and cakes, alcohol beverages and soft drinks.

The first subsector, specialized in the ethnic food market, has a huge potential market in China. However, most of them are SMEs, and they often lag behind in the modernization process and are likely to face difficulty in maintaining production advantages over competitors in nearby countries and emerging businesses in China. Already, some of them have relocated their production bases to neighboring countries which can provide abundant and low-cost labor force. On the other hand, the second and third sectors have been established as export industries from the beginning, by taking advantage of Singapore's strategic location as a regional distribution center, which allows them to obtain raw materials, such as dairy products, sugar, and flour, at competitive prices.

As far as packaging is concerned, the first and second subsectors face different issues from those felt by the third subsector. Generally speaking, a variety of food packaging materials are available today to meet diverse needs, with many packaging technologies being established. Thus, food companies rarely need to develop packaging technologies and materials specially for their own products. Rather, they have to select packaging technologies and materials suitable for their own purposes from those available in the market. Their choice is principally governed by two factors, (1) the value of food in question, determined by the market (in other words, market price), and (2) scale of demand for packaging materials.

Markets served by the first and second sectors are characterized by strong price consciousness and acceptability of lower product quality. As a result, manufacturers tend to give priority to price over quality, and there are many cases of poorness of packaging which is not detectable on visual inspection. Production capacities of most food companies in these categories is small and the companies can not necessarily procure packaging materials and machinery that meet their own specifications. Many of them have to select packaging materials or machinery which are available in the market. Thus, there have been observed some cases where they chose inappropriate packaging materials. Further, their small scale of production has impeded the automation of the packing process, so to cause real and potential quality control problems.

Food companies in the third subsector, in contrast to the above, can generally obtain the technologies for food processing, quality control, and packaging from their parent companies or partners in a corporate alliance, who often provide with packaging design also. The companies in this subsector process and/or pack foods to be supplied to international markets, and they are expected to use packaging materials and technologies conforming to international standards. At present, packaging materials which are not available in Singapore are either imported or locally produced using imported graphic

design. To maintain international competitiveness of these food companies, availability of these packaging materials needs to be improved. For this purpose, improvements should be made to increase local supply of packaging materials satisfying specifications and quality requirements for international food markets, to establish the ability to service increasingly sophisticated packaging machines, and to improve access to necessary graphic design and printing techniques.

Requirements for upgrading packaging

(1) Upgrading of food quality

The production and processing technology for food in Singapore is mainly of a well established traditional variety and not the latest technology available, and the quality of product is not high. The product quality may be affected by both quality of food itself and quality maintained by its packaging. The quality of food itself, however, is of the first importance for total quality of food product. For the upgrading of food quality, technical guidance on quality control for food processing will be effective.

(2) Upgrading of packaging quality

Problems tend to be unattended to as a result of the generally low level of quality awareness among consumers and the food industries.

(3) Upgrading of packaging technology

At present much of the processing and packaging technology employed is of a traditional, well established type but in the future it will be necessary to acquire and develop the new technologies of processing and packaging.

Packaging technology can be acquired along with the introduction of packaging machinery and packaging materials but in the case of the latest processing technology there are limits to such technology transfer. Technology transfer can be materialized only through joint venture undertakings which is accompanying investment. Thus, Singapore's attitudes towards investment, the acquisition of know-how and technology, and protection of technologies transferred, will exert a significant influence on success of acquisition of such technology.

(4) Upgrading of food processing and packaging expertise

Generally speaking, knowledge of food processing and packaging in Singapore still tends to be superficial and spotty since systematic know-how has not been acquired by the food sector and food-related packaging sector.

Therefore, it is necessary to ensure that the know-how relating not only to food processing and but also food packaging is acquired systematically.

(5) Taking measures for environmental protection

It is necessary to consider measures for responding to the two main environmental problems posed by the packaging industry, that is, the reduction of refuse resulting directly from used packaging and secondly the reduction of the industrial waste of packaging materials and packaging production.

(6) Enhancement of legal regulations and systems for protection of development technology

Enhancement of a system related to industrial rights including a patent system is necessary from an international viewpoint. With such enhancement, joint development by packaging users and suppliers, and long-term capital investment, which will contribute to promotion of technology transfer, will be encouraged significantly.

4.3 Chemical and Pharmaceutical Industry

As generally observed in the process of development of chemical industry in the world, chemical and pharmaceutical industries in Singapore are classified into the following three types: 1) small-scale chemical manufacturers which serve local demand; 2) export-oriented chemical manufacturers formed in connection with petrochemical complexes; and 3) chemical and pharmaceutical manufacturers to meet demand in Southeast Asia for high value-added products and have capability to provide technical support service.

In the case of the petrochemical subsector, given the rapid capacity expansion in the neighboring countries, Singapore can no longer rely on production of bulky commodity products alone, despite the existence of a huge potential market in China. In fact, the petrochemical industry has already started to explore applications of currently unused fractions and to expand into high value-added products, such as engineering plastics, by shoring up downstream operations.

The petrochemical complex in Singapore ships 300,000 tons of liquid products and 500,000 tons of solid products annually. Many of the liquid chemicals are designated as dangerous products.

Major developments in the fine chemical industry in Singapore are expected to take the form of downstream expansion in the petrochemical sector. In other words, expansion of the petrochemical industry into downstream, high value-added product areas, is likely to take place in the fine chemical segment including pharmaceuticals, cosmetics, soaps and detergents, and paints and dyes, keeping pace with demand growth in Southeast Asia.

In these areas, fine chemical makers are expected to do more than sales of commodity products. They have to provide technical support for customers; in the case of feedstock sales, technical advice on use as feedstocks, sub-feedstocks or additives, or joint development of feedstocks according to customer specifications; and in the case of final products, customized development of products suitable for specific market conditions. As a result, fine chemical manufacturers are required to have product development and technical support staff.

U.S. and European chemical companies have invested also in the fine chemical sector as they start to operate in Singapore. In the future, in addition to additional investment from U.S. and Europe, Japanese manufactures are expected to step up overseas production of fine chemicals, which have traditionally been produced domestically, while relocating commodity products to overseas.

For other chemical industries, there is almost no large scale chemical plant in Singapore.

Packaging in the chemicals and pharmaceuticals industry in Singapore is characterized as follows:

- 1) Locally produced products lack variety and production scale is relatively small, excepting petrochemical products.
- 2) Many imported products are used with packages made in exporting countries, and re-filling for domestic consumption, as carried out for some products, is done according to instruction from exporting countries.
- 3) They are mostly industrial products used as raw materials or intermediate goods, difficult to obtain the differentiation effect through packaging.

In addition, packaging for chemicals and pharmaceuticals have been technologically established in most parts, with little need for development of indigenous packaging technology.

Requirements for upgrading packaging

Major issues related to packages for chemicals and pharmaceuticals in Singapore are concentrated in (1) peripheral areas to packaging, and (2) work after packaging, namely the handling and transportation of packaged products.

(1) Standardization

Standardization in the areas of packaging and transportation contributes greatly to rationalization of both manufacturing and distribution. In particular, for Singapore, which serves as a regional distribution center, such rationalization not only helps

existing companies strengthen their competitiveness, but it is an essential element of the country's industrial development strategy.

(2) Need for raising awareness of related laws and regulations

Adequate package design requires sufficient knowledge of laws and regulations related to the products in question. Packaging personnel are expected to have available, at minimum, copies of laws and regulations directly related to packaging, and other relevant documentation such as the UN Recommendation on Transport of Dangerous Goods, which is known or understood only by a limited number of people in Singapore.

(3) Standardization of the methods for testing transportation packages, and development of the testing organization and system

For Singapore to fulfill its function as a regional distribution center, it is essential to establish an appropriate organization and system for testing transportation packages. Such organization and system require facilities and equipment, and manpower, which are capable of evaluating the quality and performance of transportation packages by using the generally accepted (officially accredited) method. For this purpose, 1) standardization of testing methods, and 2) the establishment of an independent testing organization capable of evaluating packages based on testing standards, are called for.

In developing the testing system, it should be kept in mind that appropriate testing and evaluation of transportation packages requires series of tests to analyze the effect of packaging.

(4) Development of packaging experts

The chemical and pharmaceutical industry also requires experts who are familiar with packaging technologies based on basic knowledge on transportation packaging and export packaging. Such experts need to be trained through a systematic program covering theories and practices in the entire packaging process, and they can not be produced by providing an unorganized assortment of knowledge and information.

4.4 Other Industries

Other industries having a close connection with packaging include the toy industry and the textile/apparel industry, which are mainly targeting export markets.

Important requirements for toy packaging are being shifted to impact resistance, vibration resistance, and even vaporproof, with increasing use of electronics components in toys.

Packages for clothing have been changed in accordance with the changes in distribution systems of major importing countries, including Japan, the U.S. and Europe. Namely, the packages are required to provide ease of unpacking at the storefront, ease of selection at the time of purchase, and other similar characteristics.

Packaging in these areas, however, does not involve much problems either in terms of availability of materials or packaging techniques.

Availability of packaging materials is rarely a problem as packaging design requirements are not strict.

Packaging technologies required for these projects are relatively simple compared to those for electric products and foodstuffs; technologies accumulated through packaging of electrical and electronic products are readily applicable. Nevertheless, making packaging materials available for small-lot and large-variety production will be important to ensure flexibility in effectively responding to future changes in the distribution pattern in import markets. Another consideration is necessity to promote automation of the packaging process. Since toys are often not easy to handle for packaging purposes, and too small in production lot to apply automation, manual labor has been used in large portions of the packaging process. Nevertheless, possible labor shortages and wage hikes anticipated in the future may make it necessary to look for ways to raise productivity through automation of the packaging process.

The most important issue related to the packaging of these industries is giving consideration to "environmental protection." Already, a problem has arisen in connection with simplification and weight reduction of packages for clothing mainly exported to former West Germany, which demands special considerations.

5 Packaging Technology Center Development Plan

5.1 Areas of Improvement for the Packaging Sector

Major issues facing the industries can be summarized as follows:

- 1) Elimination of damages to products shipped from Singapore caused by improper packages because of the design that was insufficient because of lack of consideration of shipping and handling conditions. This kind of damages are usually seen in packaging for electronic/electrical products, as well as foods exported to the Middle East market, which are susceptible to harsh transport and handling conditions.
- 2) Developing capability and facilities to perform packaging design in face of strict environmental legislation; currently, the packaging is mostly designed on a trial and error basis as the occasion demands, resulting in a significant loss of time.
- 3) Some packaging materials do not meet quality requirements due to production and/or use without consideration to meteorological conditions in Singapore; the development of rust on products due to insufficient drying of wood; the outbreak of termites or fungus in wood materials; and the bulging of corrugated cartons which are designed and manufactured without consideration to highly humid conditions.
- 4) Packaging materials which do not meet quality requirements because they were produced with use of insufficient production technology and quality control practices, such as irregular wave of corrugated paper.
- 5) Insufficient packaging due to improper packaging process is observed, particularly in poor adhesion and etching in sealing of food packages under conditions of inadequate temperature control.
- 6) There is the lack of proper packaging design support, quality packaging materials and packaging operations, that are required to develop the contract packaging ability as a distribution center by taking advantage of Singapore's locational advantage. As a result, the available contract packaging service is limited to simple packaging work on behalf of customers.

Improvement required to meet the future development of packaging user industries should be also taken into consideration, in the interest of developing the packaging sector.

In the case of the electronics/electrical industry, there will be (1) the transition to production of more sophisticated computer peripheral equipment, and (2) the strengthening of distribution functions to store components and parts from Singapore and neighboring countries for a short time and to ship them again on a just-in-time basis.

The food industry, in addition to importation of food for Malaysian market, is increasingly involved in (1) processing and packing of food materials from Southeast Asia for export to global markets, and (2) as a distribution and marketing center, repackaging food products for export to the Southeast Asian market.. In both cases, Singapore is proven to offer advanced and quality processing and packaging as well as streamlined distribution services unrivaled by her neighbors.

The chemical and pharmaceutical industry produces growing quantities of fine and speciality chemicals for sale to nearby countries. These chemicals require small-lot production of a large number of varieties, and technical service. This is also an example of Singapore's using its comparative advantages over neighboring countries, notably a labor force that uses higher technology, and efficient distribution service.

These industrial changes impose requirements on the packaging sector, to support these moves. To this end, it is expected that Singapore will develop the following abilities related to packaging technology, in addition to the issues discussed already:

- 1) Ability design to packaging for transportation of more sensitive and valuable products
- 2) Capability to produce more precisely designed packaging materials
- 3) Ability to develop packaging materials which meet increasingly diverse demand
- 4) Improved graphic design and technology of printing packages
- 5) Ability to improve packaging in consideration of distribution efficiency

The areas of improvement can be categorized into the following four.

Areas of improvement related to packaging design

Many package-related issues seen at present can not be fully solved through individual corrective measures alone. Rather, it is important to improve the packaging designing ability of the packaging sector, for which purpose there must be collection of basic technical data through analyses of strength characteristics of products to be packaged, shipping conditions, and strength of packaged goods. Also important is to improve the export packaging design ability, because most packaged goods are exported. Major tasks related to the improvement of packaging design technology are as follows:

- 1) Transport environment study and consideration of implications of the study outcome for packaging design
- 2) Improvement of packaging in light of streamlining of physical distribution system
- 3) Improvement of packaging for cost optimization

Areas of improvement related to packaging materials manufacturing

The issue is not limited to quality improvement of packaging materials supplied to the industries; packaging materials makers are expected to develop the ability to provide appropriate technical information to the packaging users.

- 1) Stabilizing packaging material quality
- 2) Enhancing marketing function played by packaging
- 3) Adjustment to diverse distribution and consumption patterns

Areas of improvement related to packaging process

- 1) Dissemination of suitable packaging process technology
- 2) Promoting mechanization of packaging process

Necessity to address environmental issues

Particularly, strengthening efforts for systematic approach to comply with environmental regulations in export markets

5.2 Actions Required for Development of the Packaging Sector and Role Played by the Packaging Technology Center

Actions required for development of the packaging sector

Actions required for developing the packaging sector can be structured into the following three levels:

- 1) Actions for improvement of packaging quality as a final goal,
- 2) The development of the packaging technology base to empower and sustain quality improvement of the packaging sector, including,
 - a) Standardization
 - b) A technical support system (for technical guidance, dissemination of information, and testing), and
 - c) A human resource development system
- 3) Nurturing and enhancing the packaging industry to support these actions.

The issues related to packaging can not be treated as individual cases. Rather, each company should deal with its own problem in a systematic manner and has to solve it from its root cause. In particular, MNCs in Singapore have to become free of dependence on parent companies and are expected to have human resources for proper management and development of packaging technology, enabling each company to solve its problem locally. This way, individual companies can learn and accumulate packaging expertise through

experience in problem solving, which should form a basis of developing the packaging sector for the country.

With efforts of individual companies to build their own resources, the packaging sector as a whole should support their activities, as discussed later (see 5.2.1.2), in order to compensate for limitations felt by individual companies. In particular, the packaging sector should assist its members in working with issues related to packaging technology. Here, the packaging sector includes those involved in packaging of package user industries, the packaging industry, the physical distribution industry, related research organizations, extension centers, training institutes, and government organizations responsible for industrial policy. Close communication among these organizations is a prerequisite for effective results. Nevertheless, activity of the packaging sector should be led basically by the private sector, that benefits from improvement in packaging technology. And the public sector should form a institutional supporting system for their activity.

Role of the Packaging Technology Center as a public technical organization

The individual companies, instead of the public organizations including the Packaging Technology Center, are assumed to play the leading role in development of the packaging sector. Also required are (1) an organization to lead in empowering related industries to assist individual companies in such efforts, and (2) an organization to support the development of technological infrastructure. Public organizations, in line with this, will provide only (1) support to the packaging sector in developing its own technological infrastructure, and (2) supplemental assistance to related industries and individual companies who are limited in ability or resources to conduct required activities.

Demarcation of functions with other public technical organizations

(1) Promotion of automation of the packaging process

Packaging Technology Center is expected to provide technical support for the software side of automation. Development of hardware required for automation of the packaging process is in rapid progress in various countries. Yet, the packaging industry in Singapore seems to be reluctant to introduce automation, despite the fact that they are facing rising labor costs and a shortage of labor supply. This is because they do not have know-how as to how the automation process be established in light of the particular conditions of Singapore, and how to integrate the packaging design and packaging management with automated packaging processes. Packaging Technology Center should focus its efforts on guidance and support in these areas, while Automation Applications Center (AAC) provides technical support in hardware aspects.

(2) Human resource development

Packaging Technology Center is recommended to emphasize human resource development through training for company management and design engineers, who are actually engaged in packaging design and manufacturing. The training should be done in keeping with the mission of SISIR to take leadership in advanced technology and quality. At the same time, the development of training programs and curricula and the provision of necessary human resources for training should be emphasized from the point of view of proliferating the results of research and development efforts to related industries and future generations.

Once the Center establishes methodology of technical guidance through its involvement in various development researches, it can transfer the function of technical guidance to polytechnics and other organizations. At that stage, the Center's technical guidance should be shifted to those which involve packaging development.

Demarcation of functions with other technology centers of SISIR

(1) Transportation packaging

Research on transportation packaging must be conducted so that the packaging be optimized over the entire packaging process and the physical distribution process. This requires collecting of required data in a systematic manner. For this purpose, Packaging Technology Center needs to have a complete set of testing equipment, regardless of equipment owned by other centers.

The research and tests on corrugated board and cartons, which is one of the most important packaging materials for transport, is recommended to be undertaken by the Packaging Technology Center, rather than the Paper and Board Testing Laboratory, because an evaluation is needed from the standpoint of transportation packaging.

At the same time, the tests, standardization and technical extension services related to transportation of dangerous goods should be one of the functions of the Packaging Technology Center, and are to be handled in a comprehensive manner in view of the nature of transportation packaging.

(2) Consumer packaging

In delineating responsibilities of Packaging Technology Center, Food Testing Center, and other technology centers, package inspection items that can be used as criteria for this purpose are classified as follows:

- 1) Condition of container itself
- 2) Direct impact of container on contents (food)
 - a) Changes in container due to contact with food

- b) Constituents of container in food
- 3) Indirect impact of container on contents (food)
 - Quality of food

Packaging Technology Center should be responsible for evaluation, related research and development, and technical guidance, on the conditions of containers, while Food Technology Center will examine the indirect effects of containers on contents. In addition, the direct effects of containers on contents are to be jointly handled by the two centers; the former is primarily responsible for containers, and the latter for constituents of containers in food. The two centers should be jointly responsible for determining alternative characteristics for quality verification of food packaging, though Food Technology Center alone should perform analysis and evaluation so as to avoid duplication of equipment and staff.

Regarding development and modification of packaging technology, and related guidance and transfer, which is the second important function of the Packaging Technology Center, Food Testing Center should assume responsibility for primary packaging which is closely associated with quality preservation and marketing functions, while Packaging Technology Center will take leadership in the issues related to the quality of packaging materials, the form of packaging, and the packaging system.

The third function – services related to analysis and standard testing for packaging materials – should be performed by Packaging Technology Center. However, tests requiring equipment which is not owned by Packaging Technology Center but is available at an other center (such as testing of gas-barrier and similar characteristics) can be performed jointly. For instance, analysis of materials and their quality performance can be performed jointly with Polymer Technology Center. In this case, however, Packaging Technology Center should appoint engineers for coordination of the testing operation for prompt and reliable service.

The fourth function, evaluation of a package's effects on marketing and consumers, is a critical function in ensuring quality improvement of food packaging and development of new products. However, evaluation is based on personal sensitivity and taste, that are not suitable for equipment analysis evaluating alternative characteristics. For this reason, it should be performed by Design Development Center and other qualified organizations. If not available, Packaging Technology Center may have to consider possible expansion of its activity into the field.

In the case of issues related to environmental compliance, those related directly to packaging materials, such as development of environment-friendly materials, etc., activities should be led by Polymer Technology Center. Packaging Technology Center

should be responsible for such functions as developing environmental compliance systems and establishing evaluation standards for environment friendly packaging materials.

Packaging Technology Center should have the function of issuing certificates as the proper third party organization.

5.3 Recommended Development Plan for Packaging Technology Center

5.3.1 Framework of the Plan

Development thrusts for the Packaging Technology Center are recommended together with programs to implement each development thrust in the following.

Thrust 1: Giving support to upgrading industries in Singapore through promotion of the advanced packaging sector

- Program 1: Accumulation of packaging technology at the Center
- Program 2: Transfer of packaging technologies to the packaging sector through joint research with industries
- Program 3: Collection and accumulation of data and development of a database related to transportation packaging through joint and own research projects
- Program 4: Development of packaging technologies reflecting packaging environment in Singapore through own research efforts
- Program 5: Collection and dissemination of packaging technology information from overseas
- Program 6: Organizing associations for the study of packaging technology
- Program 7: Stepping up of efforts to deal with environmental issues

Thrust 2: Provision of technical infrastructure for packaging development

- Program 8: Support for technological development of the packaging sector
- Program 9: Promotion of standardization in packaging
- Program 10: Development of standards testing system for packaging
- Program 11: Human resource development

Thrust 3: Evolution to Southeast/Southwest Asian Packaging Centers

- Program 12: Evolution to a packaging engineer training center for Southeast and Southwest Asian regions

Program 13: Evolution to a integrated packaging testing center for Southeast and Southwest Asian regions

Each of the above development thrusts and programs is described in the following sections.

5.3.2 Development Thrusts and Programs

Thrust 1: Giving support to upgrading industries in Singapore through promotion of the advanced packaging sector

Traditionally, the packaging sector in Singapore has been coping with packaging-related issues on a case-by-case basis, with individual companies having almost no section nor staff specialized in packaging. The existing packaging sector is not capable, therefore, of meeting the increasingly sophisticated and diverse packaging requirements now evident and expected in the future, particularly those of the electronics/electrical products industry.

The advanced packaging sector is expected to have the ability to analyze and solve problems in a systematic manner by staff specialized in packaging and having appropriate packaging technology, and to develop new packaging in a time- and cost-effective manner. Such an ability can not be learned only through seminars and training courses, but should be acquired through participation in actual research and development projects or studies on packaging damages.

These R&D projects and studies will also provide good opportunities for the packaging sector to develop new expertise.

The Packaging Technology Center can play a core role in introducing packaging technology into Singapore, transferring it to the sector and accumulating experience and expertise in this country.

Program 1: Accumulation of packaging technology at the Center

- 1) Introduction and acquisition of advanced packaging technologies and skills by the Center's staff, and the formulation of curriculum for technology transfer programs
- 2) Inviting packaging experts from other countries which have advanced packaging technology, and/or ties-up with packaging technology centers in these countries for technology acquisition

Activities

- a) To continue ongoing training programs related to packaging technology, so that staff of the Packaging Technology Center can learn packaging technology in a

systematic manner. Then, contents of these training programs will be developed into textbooks which will serve as a basis of future technology transfer to related industries, while this process will function as a follow-up process of staff training.

- b) Experts, as supporting staff, may be invited from countries having advanced packaging technology until the Center's staff attain sufficient expertise and practical experience and become capable of promoting technology transfer by themselves. These experts may come on an individual contract basis or through a technical assistance agreement with an appropriate foreign packaging technology center.

Program 2: Transfer of packaging technologies to the packaging sector through joint research with industries

To conduct joint research and development projects with related industries. At each stage of projects, relevant packaging technology and research methodology will be transferred to the participants. Major study and research projects related to transport packaging will be the following:

- a) Study on transportation environment
- b) Measurement of physical properties of packaged goods
- c) Measurement of physical properties of packaging materials
- d) Simulation test

Also, the programs should be carried out in a flexible manner to address the issues which arise from time to time and require technical assistance of the Center.

Each of the tests described above needs to be designed consistent with basic packaging technologies, and technical advice of experienced experts will be required in the process.

Program 3: Collection and accumulation of data and development of a database related to transportation packaging through joint and own research projects

To collect and accumulate data required for transport packaging design, which are obtained through joint and own research projects, in a systematic manner. The data will be indexed and sorted out to develop a database accessible by those who need the data. It will be incorporated into an outside database if suitable for the purpose.

Program 4: Development of packaging technologies reflecting packaging environment in Singapore through own research efforts

The Packaging Technology Center will undertake its own research focusing on matters related to the improvement of packaging, which are not likely to be taken up in contract research or joint research, and make the results public.

Activities

Research topics which are not usually taken up in contract or joint research projects include (1) tests to measure compression strength and vibration resistance of corrugated cardboards under temperature and humidity conditions of Singapore, (2) the experiment using dummy cargoes of varying sizes and weights to identify cargo handling conditions in Singapore and its trade partners, and (3) the measurement of vibration in different modes of transport. Also, there are various research items that can not be handled by individual companies, such as the fixing of cushioning materials, rust-proofing, dump-proofing, collective packaging, and other packaging-related technologies, and automation; development of packaging materials which are demanded by smaller packaging users who are not capable of developing on their own, and which can be made available to general users in Singapore; and data collection and analysis for development of standards discussed later.

Obtaining the assistance of foreign advisors is recommended.

Program 5: Collection and dissemination of packaging technology information from overseas

To collect and disseminate overseas packaging technology information to the related industries, thereby providing a "technological stimulus" to the packaging sector. At the same time, information so collected will be made into a database available to the packaging sector.

Activities

- a) Collection of literature and documents related to packaging, physical distribution environment, methods of testing and measuring;
- b) Collection of packaging-related standards in major countries (focusing on major export markets for Singapore);
- c) Incorporation of the above information into a database;
- d) Dissemination of information through seminars and workshops;
- e) Dissemination of latest information through periodicals of packaging technology associations, which are discussed later; and
- f) Making the database available to the packaging sector.

Program 6: Organizing associations for the study of packaging technology

To organize associations for the study of packaging technology with participation by experts from packaging makers and users, distributors and related industries, and other academic and government organizations, for the purpose of technology exchange and mutual learning to upgrade technical expertise of packaging personnel and to encourage and revitalize corporate R&D activities.

The associations will serve as the core of the packaging sector in technology exchange and mutual learning. It will be operated as a regular informal discussion session where members exchange information and ideas on the basis of the results of the Center's own research, joint research projects, and individual research projects. Major findings and discussions will be compiled and published as a bulletin.

Two or more associations may be organized for specific topics when considered necessary, e.g., an association for the study on corrugated cardboard and collective packaging.

Program 7: Stepping up of efforts to deal with environmental issues

To initiate a systematic approach to comply with environmental regulations in export markets, thereby not only assisting Singapore's manufacturing industry in effectively dealing with the issues, but also making an advancement in the attitude for environmental protection as one of the competitive edges of Singapore's products.

Activities

To organize an association for the study of environmental protection with participation by the packaging industry, user industries, and SISIR's related centers.

- a) To acquire an understanding on environmental measures and regulations enforced in major export markets; and
- b) To learn actual cases of environmental measures related to packaging in countries having advanced environmental protection measures.

In the future, the study association will propose a guideline for environmental protection measures in Singapore.

Thrust 2: Provision of technical infrastructure for packaging development

Actual development of packaging technology is conducted by individual companies. To help produce effective results from efforts of individual companies, a variety of technical infrastructures are called for, including industrial standards as norms for product development and quality control, means and tools to evaluate development results, technical assistance in product development, and means to foster human resources for packaging development. The Center will develop and provide these

technical infrastructure to support individual companies and promote the upgrading of the packaging sector.

Program 8: Support for technological development of the packaging sector

- 1) To conduct tests on packaging materials and quality on a contract basis;
- 2) To provide consulting service for improvement of packaging, based on the test results; and
- 3) To supply experts for technical assistance upon request from clients.

In addition, individual companies may want technical advice for development of new packaging technology or materials, which requires experienced experts who can provide consulting service for a variety of problems. Obviously, the Center's staff do not have the ability to provide sufficient service for every problem, or they may face a time constraint. Thus, this type of technical assistance should preferably be provided by (1) experts to be sent under the contract with similar foreign organizations, or (2) experts, domestic or foreign, who are registered with the Center and are assigned upon request.

To give proper technical advice after testing, a technical background and practical experience are required. Thus, it is imperative to engage experts at the initial stage of the program, from countries having a high level of packaging technology.

Meanwhile, proper industrial standards should be developed as the basis of evaluating test results.

Program 9: Promotion of standardization in packaging

- 1) To conduct research projects required for development of packaging-related standards;
- 2) To provide Technical Committee on Standards or the industry with technical advice on preparation and revision of draft standards; and
- 3) To promote use of standards among the relevant industries.

The Center can contribute to establishing standards by providing basic data which are essential in preparing the draft standard. These data are mainly obtained from compilation and analysis of results of joint research projects described earlier. If no data are available, the Center will collect such data through its own research, from time to time as required.

The Center's function in promoting standardization is recommended to focus on promotion instead of regulation. The promotion is recommended to be undertaken through the Center's programs to encourage use of standards.

Program 10: Development of standards testing system for packaging

While packaging companies as well as user industries have some equipment to conduct packaging-related tests, there are various tests that have to be conducted by the third party organization. Such tests are one of SISIR's important functions, and the organization is expected to have facilities and equipment capable of handling most of tests based not only on Singapore standards but also on foreign and international standards.

Activities

In principle, the center should have facilities and equipment to conduct tests related to transportation packaging. On the other hand, tests related to consumer packaging and physical properties of packaging materials can be conducted at other centers, as far as adequate equipment is available. If not, such equipment should be procured by the Packaging Technology Center or other center.

Testing equipment required to conduct transport packaging tests should be procured as soon as possible so as to offer complete testing service.

Program 11: Human resource development

- 1) To conduct training courses to develop expertise in packaging technology; and
- 2) To provide manpower to assist the industry in developing human resources.

Activities

- a) In the future, the Center is recommended to take initiative in developing its own training program to teach comprehensive knowledge of packaging technology while inviting packaging experts of various user industries and packaging industry.
- b) The Packaging Technology Center will appoint planners for training courses. Instructors will be selected from experts who are sent by outside organizations or are registered with the center.

Thrust 3: Evolution to Southeast/Southwest Asian Packaging Centers

At present, packaging technology in Southeast and Southwest Asian countries is still at a relatively low level, and many countries have strong interest in improving packaging quality. On the other hand, many MNCs operating in these countries have testing equipment for a limited number of test items only, and do not have the ability to conduct

a complete range of packaging tests. Under these circumstances, there is a clear need and opportunity for the Packaging Technology Center in Singapore to serve as a regional center offering testing and other services.

If the center can fulfill such a function, it will lead to an improved reputation for the packaging sector in Singapore, and then its industrial products. And the increased reliability on the packaging sector in Singapore will create the opportunity for the sector to earn income by providing services to countries in the region.

Program 12: Evolution to a packaging engineer training center for Southeast and Southwest Asian Regions

To conduct training courses for packaging engineers in Southeast and Southwest Asia regions

Activities

- a) Formulation of training program for packaging engineers
- b) The Packaging Technology Center will appoint planners to design training courses and will organize instructors who are mainly experts sent by foreign organizations, and registered experts.
- c) Persons who have completed the program will receive a certificate or other form of qualification.

An internationally acceptable program should be prepared through collaboration with related organizations in countries having advanced packaging technology. It will cover general items for the time being, and will be revised to reflect packaging needs in the region.

For establishing an appropriate training program and ensuring instructors, etc., seeking cooperation with foreign technical assistance organizations and packaging technology organizations is recommended.

Program 13: Evolution to a Integrated packaging testing center for Southeast and Southwest Asia Regions

To conduct standard tests on packaging on contract basis for users in Southeast and Southwest Asian countries, and to receive trainees on package testing techniques.

Activities

- a) To operate a package testing system under International Laboratory Standards;
- b) To advertise the availability of contract testing service;
- c) To establish a program to receive trainees on package testing techniques; and

- d) To expand international mutual accreditation of testing laboratory with foreign laboratories.

5.3.3 Staffing Plan

(1) Staffing

The staffing plans for individual program are shown in Figure 1 and Table 1. The staffing plan for the Center on the basis of the above is as follows:

Manager	1
Senior staff	2
Staff (Engineer)	3
Assistant staff	3
Secretary	1

(2) Staff training program

The staff training program has already started since the equipment was installed. The program implemented and the further required program are shown in Table 2.

5.3.4 Equipment Plan

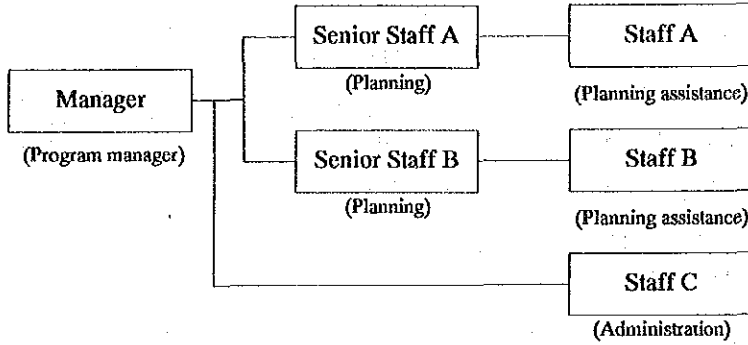
In completing the Center's equipment and facilities, it is recommended that the first priority be placed on those for transportation testing, while the services for food packaging are to be carried out making use of the existing facilities in other centers in SISIR. The service programs and required equipment and facilities for food packaging should be examined after completing those relating to transportation packaging. Of the services related to transportation packaging, the testing services for quality of packaging materials is recommended to be carried out using the equipment owned by other centers. Also, the testing services for transportation of dangerous goods should be undertaken using the existing equipment of other centers, if necessary.

(1) Transport package-related equipment

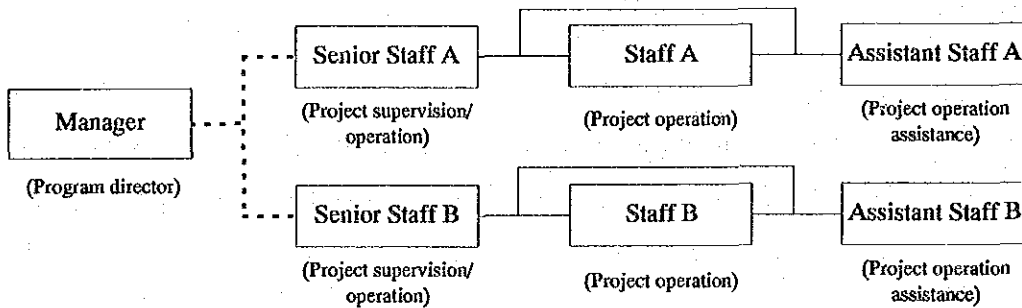
Major testing equipment required for transport packages is described below. As for the equipment and facility relating to transport packaging, the existing equipment (as of March, 1993) will enable the Center to carry out most items of standards testing and contract testing. However, for the more sophisticated and systematic packaging tests and research works, the existing equipment will be insufficient. In view of upgrading the Center to meet the needs of the packaging user industries, which will become

Figure 1: Recommended Organization Chart for the Program Implementation by the Packaging Center

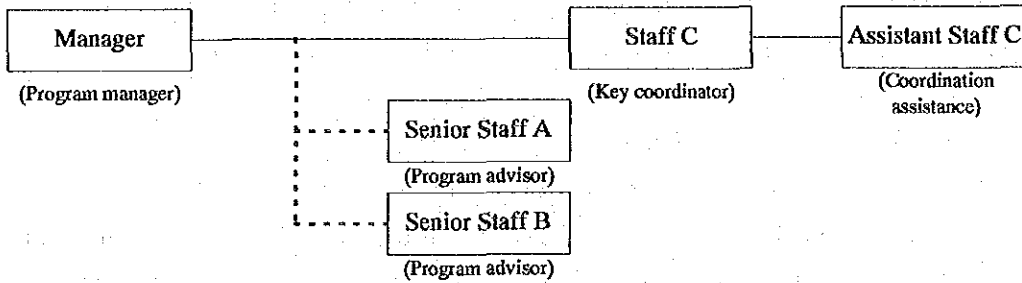
(1) Development planning (Programs 1 & 10)



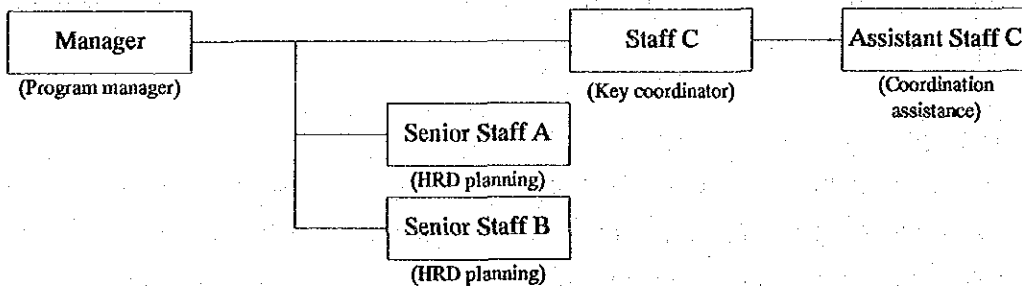
(2) Technology development & technical assistance (Programs 2, 3, 4, 8 & 13)



(3) Project coordination (Programs 7 & 9)



(4) Human resource development (Programs 11 & 12)



(5) Information service and marketing (Programs 5 & 6)

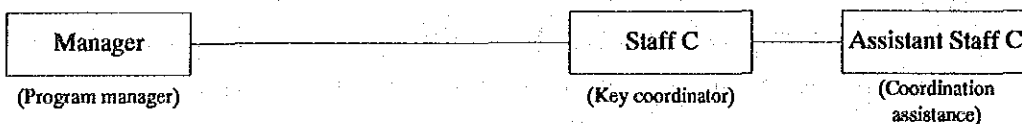


Table 1: Recommended Manning Plan for the Packaging Center

Program	Manager	Senior Staff (Scientist)		Staff (Engineer)			Assistant Staff (Technician)			
		A	B	A	B	C	A	B	C	
		1	Accumulation of packaging technology at the center	⊙	●	●	○	○	○	
2	Transfer of technologies through joint research		⊙	⊙	●	●		○	○	
3	Collection and accumulation of packaging data		⊙	⊙	●	●		○	○	
4	Development of technology through own research		⊙	⊙	●	●		○	○	
5	Collection/dissemination of technical information	⊙					●			○
6	Organizing societies for the study of technology	⊙	○	○	○	○	○			
7	Stepping up of efforts against environmental issues	⊙	△	△			●			○
8	Support for development of the packaging sector		⊙	⊙	●	●		○	○	
9	Promotion of standardization in packaging	⊙	△	△			●			○
10	Development of standards testing system	⊙	●	●	○	○	○			
11	Human resource development	⊙	△	△			●			○
12	Training center for S.E./S.W. Asia regions	⊙	△	△			●			○
13	Testing center for S.E. & S.W. Asia regions		⊙	⊙	●	●		○	○	

Note: ⊙ Program manager, ● Key staff, △ Supporting staff, ○ Assistant staff

Table 2: Staff Training Plan for the Packaging Center

Subject	Required period for the training	Training completed	Minimum requirement for:			
			Manager	Senior staff/ Staff	Assistant staff	
1 Packaging technology in general	Basic Standardization Standard development	1 month 2 months 2 years	2 weeks	×		
2 Physical distribution in general *1)	Basic Physical distribution technology	1 month 2 years	3 weeks	×		
3 Transport packaging materials	Basic Quality control	2 months 1 month	3 weeks	×	×	×
4 Transport packaging technology *2)		3 months	3 weeks		×	
5 Transport packaging design *3)		6 months	6 weeks		×	
6 Package testing *4)		3 months	3 weeks	×	×	×

Notes:

*1) including pallet & containers

*2) Corrosion preventive technology, moisture proof technology, collective packaging, etc.

*3) Cushioning packaging design, corrugated container packaging design, etc.

*4) Methodology, equipment operation, analysis, and evaluation

increasingly sophisticated, installation of additional equipment is recommended. The most important equipment and facilities to be added include (1) a shock testing system, (2) a drop dynamic testing machine for package cushioning materials, and (3) a light vibration table used for up to 500 Hz.

- 1) Testing equipment related to transport packaging
 - a) Testing equipment and materials to simulate transport conditions
 - b) Testing equipment to check damage susceptibility of products, and
 - c) Measuring instruments to check transport environment
- 2) Equipment to test performance of packaging materials

(2) Consumer package-related equipment

The Center will carry out the services in the area of food packaging in close cooperation with the Food Technology Center at the outset, but the basic policy in the future, of equipment plan for food packaging is that the Packaging Technology Center will take responsibility for undertaking services related to packaging materials in this field.

5.3.5 Operation Plan

Financial evaluation of the operation

Major revenue sources for the Packaging Technology Center are as follows:

- 1) Standards testing service
- 2) Other contract testing and contract research service
- 3) Joint research
- 4) Short-term seminars
- 5) Training courses for packaging engineers

The center is expected to generate an operating deficit of S\$36,000 (equivalent to 37% of total revenue) in the fourth year when the government subsidy to supplement operating cost will be terminated, excluding depreciation expenses for machinery and equipment. Then, the deficit will decrease slightly as demand for the center's service increases, and cash flow will turn positive in the eighth year, although depreciation has still to be completed.

(Unit: S dollar)				
Year of Operation	2nd	4th	6th	8th
Revenue				
Fees for contract testing	125,000	176,000	250,000	352,000
Fee for contract researches	205,000	282,000	410,000	563,000
Entry fee for joint researches	54,000	54,000	107,000	107,000
Entry fee for short-term seminars	49,000	68,000	93,000	129,000
Entry fee for training courses	0	86,000	118,000	161,000
Membership fee for research association	18,000	38,000	40,000	41,000
Contract testing fee from overseas clients	13,000	35,000	47,000	62,000
Total revenue (a)	464,000	739,000	1,065,000	1,415,000
Operation cost				
Direct Labor Cost	204,000	378,000	378,000	378,000
Overhead Cost	306,000	567,000	567,000	567,000
Maintenance Cost	10,000	31,000	51,000	62,000
Other Operation Costs	20,400	48,400	80,600	80,600
Operation Cost Total (b)	540,400	1,024,400	1,076,600	1,087,600
Balance [(a)-(b)]	-76,400	-285,400	-11,600	327,400
(Depreciation)	411,000	411,000	0	0

The above financial projection assumes only the equipment required urgently will be added to the existing equipment and covers costs of staff proper to the testing and research services alone, excluding other parts of staff costs (costs for a half of that of the manager, a staff, an assistant staff, and a half of that of the secretary), which are related to SISIR's functions for promotion of standardization, dissemination of technology information, etc., and are to be compensated by the government budget .

The projection also assumes the additional revenues from (1) member fee from organizing study associations relating to packaging technology, and (2) receiving orders from overseas clients.

According to the financial projection, the balance will turn to be positive in the seventh year at single fiscal year basis, with the accumulated balance becoming positive at the ninth year. Nevertheless, it will be difficult to be cover depreciation. Under such a situation, to upgrade the function of the Center further, and to maintain the existing equipment with appropriate renewal, thereof the support of the government should also be considered particularly in financing. Such financing support of the government may be justified in view of the social and economic effects anticipated from establishment and activity of the Center.

Other Issues Related to Management

(1) Needs for strengthening relations with related industries

1) Effective communication

To ensure that the intent of the packaging sector is reflected in the Center's activity to properly address needs of the sector that change from time to time, it is important for the center to have a place of regular communication with representatives of the packaging sector in order to discuss on management policy and strategy of the center. Note that the packaging sector should include the packaging industry, industrial users of packaging service and materials, and the physical distribution industry.

2) Associations for the study of packaging technology bridging the center and related industries

Needless to say, the center's activity has to address needs of related industries, and its research projects should be conducted with close collaboration of related industries to reflect the current state and problems facing them. Also, the outcome of research projects should be provided to the industry side so as to be utilized by the latter. The study associations devoted to packaging technology can play a central role in meeting the above demand. It serves as an opportunity for the packaging sector to participate in industry-wide joint efforts. At the same time, the Center can use the study associations as principal partners in activity to promote modernization of the packaging sector.

(2) Level of service fees and improvement of government subsidy system

While service fees of SISIR set at market price are affordable for MNCs and their joint venture companies, they are likely to be very costly for local SMEs.

At present, the local SMEs which use SISIR's service are eligible for a government subsidy which covers 50% of the actual fee. However, there are many complaints about complicated application procedures and the relatively long period of time required for processing. To be able to set the service fees at a market price level, and make it affordable to all the potential users, therefore, the government subsidy program should be reviewed and improved to maximize its use by eligible enterprises.

(3) Need for completing testing equipment

The plan assumes that testing for food packaging will be undertaken as a joint service with and using the equipment of the Food Technology Center, if available. As for the testing equipment and facilities relating to transport packaging, however, further efforts for installation of additional equipment and facilities are recommended to provide the packaging users with the more sophisticated technical services required for their

advancement, in addition to the services in the basic testing fields currently available. The most important equipment and facilities among others include, (1) a shock testing system, (2) a drop dynamic testing machine for package cushioning materials, and (3) a light vibration table use for up to 500 Hz.

(4) Maintenance and upgrading of equipment

Equipment maintenance needs to be carefully planned to ensure smooth operation of the center, including adequate maintenance by contract and proper budgeting. Also, equipment should be upgraded in a timely manner to provide the highest practicable level of service all the time, by addressing changing industry's needs and technological requirements.

(5) Alliance with counterparts in countries having advanced packaging technology

Such basic activities of the Center as standards compliance tests, and certain contract tests, may be performed by its staff with the planned recruitment and the training programs. However, to keep abreast of rapidly advancing packaging technology, and to provide appropriate technical guidance and technical information services required in accordance with the sophistication of the industries, the Center is recommended to make the most of the support available from the similar organizations in countries with advanced packaging technology, through teaming up with these organizations, particularly until the packaging sector in Singapore can develop its ability to be the counterparty of the Center in developing packaging technology in this country.

5.3.6 Socioeconomic Effects of Packaging Technology Center Development

The project is expected to generate the following effects. Although the project is not the only way to achieve such goals, it is sure to maximize the effects if properly administered.

(1) Economic effects

1) To encourage import substitution for packaging materials

Quality improvement of locally produced packaging materials will make it possible to substitute for imported ones that dominate the market. Note that not all the imported packaging materials can be replaced with local products; there must be a critical mass to support local production.

2) To achieve cost reduction by decreasing damage to exported goods

Since many products exported from Singapore use imported raw materials and components, the decrease in damage and loss to exported products through improved packaging would lead to the decrease in the requirement for materials imports, and thereby have positive impact on the country's trade balance.

3) To make a social contribution through lean packaging

If excesses are removed from packaging for locally sold products, in addition to export products, it will contribute significantly to society by reducing waste disposal cost.

4) To explore new export markets

Improved packaging can extend shelf life of products, particularly of foodstuffs, leading to geographical expansion of potential export markets.

(2) Other indirect and intangible benefits

1) Accumulation of advanced packaging technology and promotion of product development

Introduction and diffusion of production technology will replace previous packaging improvement practices based on copying or trial and error with package design and management techniques, and instead will establish a scientific basis. Once advanced packaging technology takes root throughout the country, it will serve as a basis of developing proprietary design, technology, and materials.

2) Streamlining of the physical distribution system

Improved and uniform packaging will promote standardization of physical distribution systems and will enable the streamlining of distribution operations, such as integrated transportation.

3) Improvement of packaging quality

Establishment and improvement of testing standards and product specifications for packaging and cushioning materials, together with improvement of testing service, will facilitate specification and certification tests, leading to promotion of certification by a third party organization, and improvement of packaging quality.

4) Contribution to international competitiveness of manufacturing industry

For any country and particularly Singapore, the improvement of product quality in terms of performance and precision is essential for the manufacturing industry to raise its international competitiveness. The packaging sector is an important element supporting such quality improvement. Also the powerful packaging sector will reduce the time-to-market duration for products, which is a critical factor in determining manufacturers' international competitiveness.

5) Promotion of supporting industries

The packaging industry, particular converters, is made up of relatively small enterprises. Thus, promotion of the packaging sector directly leads to promotion and strengthening of SMEs. This clearly helps ameliorate two major issues facing the manufacturing sector in Singapore, a widening gap between foreign-affiliate corporations and local enterprises, and the lack of supporting industries.

6) Development of the packaging sector, to become an export industry

Neighboring countries face issues related to packaging, similar to those in Singapore, which are solved by overseas parent companies in the case of MNCs. Once Singapore has an advanced packaging sector, it will be able to meet needs in neighboring countries for improved packaging. For instance, the packaging industry can grow to 1) expand their production bases in neighboring countries, 2) export packaging materials, and 3) extend consulting service to the users in neighboring countries. At the same time, the Packaging Technology Center is expected to provide the packaging industry and users in neighboring countries with the following services: a) research and study on transportation and distribution environment, b) development test, c) standards tests and quality certification tests, and d) human resource development.

JICA