conventional folding cartons. Packages for underwear, female clothes, and socks are also becoming simpler in form, with some variation depending upon the particular form of sales.

Another factor in affecting packages for clothes, like many other products, is the public concern about environmental protection and recycling. The restricted use of PVC and foamed polystyrene are requiring the clothing industry to use environmentally-friendly materials and packages. In particular, environment-related characteristics, such as the ease of recycling, energy saving, and resource saving, are weighed heavily. In Germany, for instance, the significant downsizing of packaging containers is being progressed and newly developed packaging methods and materials are rapidly replacing old ones.

3.4.2 Current Situation of Packaging in Singapore

(1) Toy

Most of toys produced in Singapore are exported to Japan, the U.S., and Europe.

For ordinary toys not using electronic parts, primary packaging is not important and uses simple paper boards or polyethylene bags. Packages for transportation also use simple corrugated fiberboards because of high durability of packaged products to eliminate the need for special package design. However, for relatively heavy products, containers for transportation should be designed in size that takes into account their durability against the weight.

On the other hand, toys using electronic components, such as radio-controlled cars, home video game systems, as well as plastic toys made by precision molding are packed in containers to have sufficient shock resistance or vibration resistance, such as those combining styrene foam molded containers with paper board covers, and those combining paper board folding boxes or sleeve cartons with retainers, thermo-formed plastic sheets.

(2) Household merchandise and office supplies

Since kitchen equipment produced in Singapore is mostly consumed within the country, many of them are packaged in a relatively simple form. Also, the use of new packaging materials and forms is not seen widely.

While relatively lightweight products have traditionally been packed directly in paper board boxes, or wrapped in plastic bags and placed in containers, recent changes in the form of sales have led to the increase in products that are packed in paper board

boxes after wrapping in blister packs or bags with paste-backed labels, or individual wrapping in auto bottom paper board cartons with flaps.

On the other hand, relatively heavy products continue to be sold in paper board or corrugated fiberboard cartons, with some improvements on printing and package design.

(3) Clothes and garments

Most of clothes and garments produced in Singapore are exported to the outside the ASEAN countries, mainly the U.S. and Europe. Major types of products are outerwear, mostly sports shirts, knit shirts, and jackets. Dress shirts, folded into a specific shape by using paper boards, pins, and plastic clips, are placed in plastic bags. Casual shirts are directly placed in plastic bags, without paper boards and other accessories to keep in shape. Finally, off-the-peg clothes displayed on coat hangers are packed collectively or individually, depending upon their sales price.

3.4.3 Major Characteristics of Packaging in Singapore

Packages for products of other industries – mainly export products such as toys and clothes – are primarily affected by distribution conditions and market environment in importing countries.

For toys using electronic components, packages having resistances to shock, vibration and drop are required. Packages for clothes have been changed with the changes in distribution systems of major importing countries, including Japan, the U.S. and Europe. Today, the packages are required to provide the ease of unpacking at the storefront, the ease of selection at the time of purchase, and other similar characteristics.

3.4.4 Major Issues Related to Packaging

Packaging in these areas does not involve much problems both in terms of availability of materials and packaging techniques.

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

Regarding packaging materials, availability never be a problem for conventional products mainly using paper boards and plastic bags. Similarly, styrene foams and PVC sheet molded materials for toys using electronic components are relatively easy to obtain, because of relatively lightweight contents compared to electrical products, although the accuracy of molding and moldability sometimes become a problem.

By the same token, PVC molded products and paper boards used for blister packaging of household merchandise, and paper boards used for cartons are readily available.

However, corrugated fiberboards with fine flute type E, often used for heavy products in Japan and other countries, are only produced in small quantities in Singapore and need to be imported.

Packaging materials for clothes are generally available in Singapore, excepting some types of films. Nevertheless, they do not require particularly high levels of grade and quality.

Packaging techniques required for these products are relatively simple compared to those for electric products and foodstuff; techniques 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 distribution pattern in importing countries. Another consideration is that toys are often not easy to handle for packaging purposes, while requiring manual labor in large portions of the packaging process due to the difficulty in automating small-lot production. Nevertheless, possible labor shortages and wage hikes anticipated in the future may make it necessary to look for the ways to raise productivity through automation of the packaging process.

The most important issue related to these areas is consideration to "environmental protection." Already, a problem arises in connection with simplification and weight reduction of packages for clothes mainly exported to former West Germany, demanding specific considerations. Also, materials and shapes need to be reconsidered for packages using cartons and plastic bags.

In Germany, for instance, the cost of mandatory collection of a container varies with weight and type of material as well as disposal cost, so that a plastic container may have to be changed to a paper one, in addition to efforts for size reduction. At the same time, as size reduction and material modification have large impacts on external appearance of packaging, leading to the changes in marketing features, continuous research and development of packages to satisfy these conflicting requirements in a balanced manner are called for.

Finally, looking at environmental protection measures, many countries enforce varying types of legal control, and technical evaluation on disposal and recycling methods has still to be harmonized, in reflection of conditions and social institutions peculiar to each country. For the time being, therefore, it is important to collect relevant information on national environmental protection measures to allow package design in consideration to local conditions.

Table 3-1 Demand Forecast of Eelctronics Products by Area and the Selected Countries in the World

(Unit: million S$)

	1988		1992	1995	2000
World Total	549,237	(100.0)	741,208	935,309	1,423,689
Japan	110,375	(20.1)	149,725	190,723	293,295
Asia Total excl. Japan	40,108	(7.3)	59,289	76,713	119,045
Korea, Rep. of	9,750	(1.8)	15,123	20,150	32,635
Taiwan	6,255	(1.1)	9,154	12,120	19,595
Honkong	3,563	(0.6)	4,749	5,810	8,178
Singapore	4,472	(0.8)	6,750	8,718	13,381
Others in Asia	16,068	(2.9)	23,514	29,915	45,256
U.S.A.	188,120	(34.3)	244,110	301,922	448,674
Europe	141,065	(25.7)	187,117	230,263	336,895
Germany, FDR	30,747	(5.6)	39,663	48,397	70,714
France	24,419	(4.4)	31,332	37,968	54,276
U.K.	25,852	(4.7)	34,433	42,512	62,717
Others in Europe	60,047	(10.9)	81,689	101,387	149,188
Others	69,569	(12.7)	100,966	135,689	225,780

Note: Figures in the parentheses show percent of world total

Source: Japan Electronic Industry Development Association (May, 1990)

Table 3-2 Production of Electronics Products by Industry or by Area/Selected Countries in the World

(Unit: million S$)

	1988	1992	1995	2000
World Total	549,237	741,208	935,307	1,423,688
By Industry				
Electronic Machinery	409,053	549,966	687,710	1,020,991
Audio	69,472	81,756	94,730	124,043
Transmission Devices	111,174	149,021	185,728	273,701
Computer	157,331	225,584	293,567	464,119
Office Equipment	18,914	22,205	24,889	30,606
Measuring Devices	32,057	43,779	53,948	76,937
Others	20,105	27,621	34,848	51,585
Electronic Parts	140,184	191,241	247,597	402,697
Ordinary Electronic Parts	68,480	83,690	97,122	125,845
Electronic Devices	71,704	107,552	150,476	276,852
By Country				
Japan	160,682	212,856	265,911	400,634
Asia Total excl. Japan	59,266	92,813	124,156	199,793
Korea, Rep. of	17,050	27,981	38,117	62,811
Taiwan	11,453	17,795	25,537	37,438
Honkong	3,578	5,059	6,255	8,877
Singapore	9,590	14,815	19,424	30,086
Others in Asia	17,595	27,163	36,824	60,582
U.S.A.	162,603	210,164	260,753	388,819
Europe Total	117,590	156,442	194,344	287,843
Germany, FDR	30,259	39,829	49,465	73,752
France	19,808	25,268	30,776	44,571
U.K.	20,057	26,925	22,687	50,791
Others in Europe	47,466	64,420	80,417	118,728
Others	49,096	68,933	90,143	146,599

Source: Japan Electronic Industry Development Association (May, 1990)

Table 3-3 Principal Statistics of Singapore Electronic & Electric Industry

(1) Electronic Products Components

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	UNIT
Out Put	5,678,990	5,195,432	6,891,033	9,569,488	9,014,035	11,214,475	16,409,591	21,590,329	24,692,256	27,878,127	1,000 S$
Value Added	1,627,171	1,465,551	1,890,865	2,894,738	2,838,830	3,676,865	5,011,737	6,278,524	6,979,841	7,716,639	1,000 S$
Direct Export	5,030,508	4,569,093	6,130,400	8,228,470	8,328,742	10,009,652	13,926,089	18,633,528	20,950,759	24,026,712	1,000 S$
Capital Expenditure	282,327	309,116	369,793	612,550	631,892	718,617	1,165,046	1,347,077	1,558,974	1,403,718	1,000 S$
Value Added per Worker	23.5	24.1	28.7	39.6	43.3	53.5	59.0	56.3	60.1	62.8	1,000 S$
Output Per Worker	81.9	85.5	104.7	131.0	137.4	163.1	193.3	193.5	212.7	227.0	1,000 S$
Material to Output	69.0	68.6	69.2	66.5	65.3	64.4	66.8	67.8	69.1	69.4	%
Value Added to Output	28.7	28.2	27.4	30.2	31.5	32.8	30.5	29.1	28.3	27.7	%

(2) Electrical Mchinery, Apparatus, Appliances & Supplies

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	UNIT
Out Put	1,078,666	1,017,615	1,224,317	1,482,520	1,337,225	1,458,483	1,842,996	2,182,506	2,517,186	2,433,948	1,000 S$
Value Added	404,354	403,963	464,521	573,393	519,800	545,111	663,726	784,142	893,797	879,817	1,000 S$
Direct Export	702,872	648,717	752,883	920,760	933,406	1,015,469	1,226,826	1,375,831	1,469,513	1,554,628	1,000 S$
Capital Expenditure	117,379	130,662	92,914	112,122	111,556	131,280	180,889	182,134	226,116	204,266	1,000 S$
Value Added per Worker	23.8	26.7	28.4	33.1	30.8	33.6	35.2	35.5	40.0	40.0	1,000 S$
Output per Worker	63.6	67.3	74.9	85.5	79.2	89.8	97.8	98.9	112.5	110.7	1,000 S$
Material to Output	57.6	55.2	56.8	55.9	55.5	57.4	59.9	59.9	60.2	58.6	%
Value Added to Output	37.5	39.7	37.9	38.7	38.9	37.4	36.0	35.9	35.5	36.1	%

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

Table 3-4 Singapore Import/Export to Thailand, 1991

(Unit: 1,000 S$)

	Import	Export	Domestic Export
Television Receivers Color	116,411	94,927	82,308
Modems	14,192	–	–
Loudspeakers	31,538	10,968	4,417
Parts of Line Telephonic or Telegraphic Apparatus	–	10,601	6,619
Parts of Television & Radio-broadcast Receivers & Telecom Apparatus incl. Aerials & Aerial Reflectors	13,512	146,846	84,296
Parts of Video Sound Recorders & Reproducers	81,132	39,208	34,772
Cathode-ray Television Picture Tubes Colour	23,102	49,649	49,359
Other Diodes	–	18,665	10,121
Transistors	15,453	14,374	5,038
Integrated Circuits	383,531	237,634	90,231
Mounted Piezo-electric Crystals	14,765	3,618	1,906
Parts of Diodes Photocells Transistors etc	–	32,973	30,066

Source: Singapore Trade Statistics, 1991

Table 3-5 Singapore Import/Export to Malaysia, 1991

(Unit: 1,000 S$)

	Import	Export	Domestic Export
Television Receivers Color	932,973	15,541	2,346
Telephone Sets	78,620	–	–
Facsimile Machines	–	10,106	3,920
Other Line Telephonic or Telegraphic Apparatus	69,670	–	–
Loudspeakers	70,336	48,041	26,854
Amplifiers	129,663	–	–
Transmitters & Transmitter-receivers	11,458	17,005	1,788
Radio Navigational Aid Rador & Remoto Control Apparatus	77,586	–	–
Parts of Line Telephonic or Telegraphic Apparatus	18,643	18,982	6,177
Parts of Microphones Amplifiers etc	29,725	8,811	3,937
Parts of Television & Radio-broadcast Receivers & Telecom Apparatus incl. Aerials & Aerial Reflectors	534,007	514,001	281,523
Parts of Video Sound Recorders & Reproducers	475,441	390,334	106,530
Cathode-ray Television Picture Tubes Color	94,164	391,840	158,261
Parts of Electronic Valves & Tubes	38,644	–	–
Other Diodes	86,438	58,034	28,792
Transistors	144,461	108,712	78,867
Other Semi-conductor Devices	34,843	128,122	415
Microassemblies	12,431	–	–
Integrated Circuits	1,215,111	467,061	254,563
Mounted Piezo-electric Crystals	24,932	20,072	6,807
Parts of Diodes Photocells Transistors etc	69,503	146,647	96,084

Source: Singapore Trade Statistics, 1991

Table 3-6 Singapore Import/Export to Japan

(Unit: 1,000 S$)

	Import	Export	Domestic Export
Television Receivers Color	298,421	46,555	13,244
Telephone Sets	100,076	–	–
Facsimile Machines	108,054	–	–
Loudspeakers	–	17,540	10,711
Transmitters & Transmitter-receivers	115,657	28,346	27,460
Television Cameras	212,872	–	–
Radio Navigation Aid Rador & Remoto Control Apparatus	–	15,060	6,726
Parts of Television & Radio-broadcast Receivers & Telecom Apparatus incl. Aerials & Aerial Reflectors	419,022	66,196	42,682
Parts of Video Sound Recorders & Reproducers	649,861	139,195	96,774
Cathode-ray Television Picture Tubes Color	235,058	22,667	22,665
Other Diodes	125,868	11,027	10,524
Transistors	142,360	5,687	4,741
Other Semi-conductor Devices	–	10,086	7,837
Integrated Circuits	1831023	487,732	337,133
Mounted Piezo-electric Crystals	127,995	20,151	1,906
Parts of Diodes Photocells Transistors etc	206,773	15,341	4,342

Source: Singapore Trade Statistics, 1991

Table 3-7 Profile of Singapore Electronic & Electric Industry, 1990

(1) Electric Products and Components

Industry	Establishments	Workers	Workers per Establishment	Output	Total Sales	Direct Exports
	A (no.)	B (persons)	B/A (persons)	(1,000 S$)	(1,000 S$)	(1,000 S$)
Electric Motors, Generators	17	4,639	273	440,711	448,332	286,966
Transformers	10	858	86	113,991	113,934	46,094
Switchgear & Switchboard	32	3,266	102	300,004	302,499	210,351
Apparatus including Switches, Electrical Power Cables & Wires	7	401	57	100,413	100,693	12,872
Wire & Cable Assemblies & Harnesses	18	1,980	110	213,913	213,893	72,779
Connectors	9	1,631	181	225,916	223,683	136,546
Storage & Primary Batteries	5	2,693	539	200,091	205,886	180,222
Electrical Lighting Equipment, Fitting & Parts	10	305	31	28,330	28,194	9,984
Electrical Household Appliances	6	3,783	631	424,360	428,794	416,630

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

(2) Electronic Products and Components

	Establishments	Workers	Workers per Establishment	Output	Total Sales	Direct Exports
	A	B	C			
	(no.)	(persons)	(persons)	(1,000 S$)	(1,000 S$)	(1,000 S$)
Computer & Data Procesing Equipment	18	1,784	99	1,058,315	1,082,797	967,980
Disk Drives	13	28,335	2,180	7,354,756	7,380,726	7,054,950
Computer Peripheral Equipment	18	10,420	579	3,419,566	3,467,303	3,118,379
Communication Equipment	10	9,781	978	1,353,539	1,354,917	1,234,251
Television Sets & Subassemblies	6	5,808	968	1,668,756	1,671,314	1,490,502
Microphones, Loudspeakers & Amplifiers	5	2,889	578	336,702	337,690	211,020
Audio & Video Combination Equipments	9	11,571	1,286	2,942,006	2,967,576	2,731,871
Semi-Conductor Devices	23	15,116	657	3,226,931	3,296,457	3,033,608
Capacitors	9	3,448	383	356,053	350,489	208,463
Resistors	7	1,158	165	73,440	72,505	53,186
Printed Circuit Boards without Electronic Parts	21	5,346	255	620,916	621,553	229,426
Printed Circuit Boards with Electronic Parts	62	13,508	218	2,909,033	2,910,075	1,879,632
Other Electronic Products & Components Nes	39	13,633	350	2,558,113	2,627,697	1,813,443
Total	240	122,797	512	27,878,126	28,141,099	24,026,711

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

Table 3-8 Damages of Electric/Electronic Products during Distribution and Packaging Plan Techniques

Damages	Contents	Packaging Plan Techniques applied
1. Chemical Damages	Rust	Rust preventive packaging
	Corrosion	Water-proof packaging
		Corrosion preventive packaging
2. Physical Damages	Vibration Damage	Shock cushioning packaging
	Shock Damage	Vibration cushoning packaging
	Compressive Damage	Stacking load packaging

Table 3-9 Procedure of Cushoning Packaging Design for Electric and Electronic Products

Phase 1	Transport Environment Survey	Shock environment sruvey (height (Hcm), frequency, direction)
		Vibration environment survey (frequency (fHz), level (G))
Phase 2	Product Fragility Study	Shock fragility survey (maximum velocity/acceleration (damage boundary curve))
		Vibration fragility survey (critical resonant frequency)
Phase 3	Selection of Cushoning Material	Selection of the materials that will most economically absorb those shocks and vibration
Phase 4	Cushioning Design	Use of the shock cushoning curve and vibration transmissibility curve
		Determination of the bearing area and thickness
		Creep, buckling stress
Phase 5	Packaged Freight Test	Drop test, vibration test

Table 3-10 Evaluation Test Items for Reproducing Distribution Environment

Evaluarion Test Items for Reproducing Distribution Environment	Rate of Acceptance(%)*
· Drop test (Free drop, One-side support drop)	100
· Vibration test (Sine wave sweep, Random Vibration)	100
· Compression test	100
· Fall test	90
· Stepping test	80
· Load creep test	50
· Passive drop test	50
· Incline impact test	30
· Dragging test	25
· Corner slide Compression test	25
· Throw test	25
· Bending test	25
· Other (Side clamp test, Knee handling test, Back handling test, Load drop test, Corner rolling test, Lifting test, Slipping test Revolving hexagonal draw test)	10

*) Situation of acceptance in japanese makers of electric/electronic products.

Table 3-11 Foods in Singapore and Their Quality Characteristics

	Main Products	Main Markets	Quality Characteristics		
			Package Type	Package Quality	Product Quality
1	Some soft drinks and confections	International	A	A	A
2	Beverages, spices, and frozen foods	Chinese ethnics	A	B	B
3	Raw confections, noodles, and traditional foods	Domestic	B	C	C

Notes: A=World class, B=2nd class, C=3rd class

Table 3-12 Volume of Waste and Population in Singapore

(Units: 1,000 tons, 1,000)

Year:	1986	1987	1988	1989	1990	1991	2000
Volume of Waste	1,595.7	1,872.9	1,834.8	1,979.4	2,079.1	2,151.7	2,411.9
Population					2,690		3,230

Source: "The Singapore Green Plan"

Table 3-13 Products and Imported Food Handled in Food Stores

(Unit: %)

	Fresh Foods	Processed Foods	Non-foods	Total
Percent in stores	50	40	10	100
Percent of imported foods	80	20	na	

Note: na=Not available

Table 3-14 Quality Standards and Expiration Dates

Quality Standards				Expiration Dates
1	Microbe	(Critical Level)		3 year or more
2	Nutrition	(Edible Level)	Main Ingredient	less than 3 years
			Sub-ingredient	less than 1 year
3	Main Sensory Characteristics	(Low Sensory Level)		less than 2 years
4	Preference Sensory Characterisrics	(High Snesory Level)		several months

Table 3-15 Relationship between the Green Mark System and Packaging Factors

		Packaging Materials	Packaging Machinery	Packaging Technology
Product characteristics demanded	1. Use more recycled materials	○		○
	2. Environmental friendliness	○		○
	3. Noise control		○	
	4. Energy saving	○	○	○

Table 3-16 Product Structure of Selected OECD Chemicals, 1988

(Unit: Million US$,(%))

	US		Europe		Japan	
	mil. US$	%	mil. US$	%	mil. US$	%
Industrial Chemicals	62.5	(53)	82.0	(56)	56.0	(61)
Agricultural Chemicals	14.0	(12)	19.5	(13)	8.0	(9)
Pharmaceuticals	41.3	(35)	46.6	(31)	27.8	(30)
Total	117.8	(100)	147.5	(100)	91.8	(100)

Source: OECD, "Globalization of Industrial Activities", (Paris:1992)

Table 3-17 Supply and Demand of World Chemicals

(Unit: US$ billions)

	Supply			Domestic Consumption (Estimated) (B)		Export	(A/B)
	Production (A)	Import	Total				(%)
Industrial Chemicals							
US	62.5	6.0	68.5	60.0	(23.1)	11.0	104.2
Europe	82.0	-7.0	75.0	75.0	(28.8)	6.0	109.3
Japan	56.0	60.0	116.0	55.0	(21.2)	60.0	101.8
Other OECD	8.5	3.0	11.5	8.0	(3.1)	3.0	106.3
Total OECD	**209.0**	**62.0**	**271.0**	**198.0**	**(76.2)**	**80.0**	**105.6**
Non-OECD				**62.0**	**(23.8)**		
World Total				260.0	(100.0)		
Agricultural Chemicals							
US	14.0	1.0	15.0	10.0	(20.0)	4.2	140.0
Europe	19.5	6.2	25.7	13.0	(26.0)	7.4	150.0
Japan	8.0	0.4	8.4	8.0	(16.0)	0.3	100.0
Other OECD	2.4	0.4	2.8	2.0	(4.0)	1.0	120.0
Total OECD	**43.9**	**8.0**	**51.9**	**33.0**	**(66.0)**	**12.9**	**133.0**
Non-OECD				**17.0**	**(34.0)**		
World Total				50.0	(100.0)		
Pharmaceuticals							
US	41.3	2.8	44.1	41.0	(23.2)	3.2	100.7
Europe	46.0	11.8	57.8	48.0	(27.1)	17.5	95.8
Japan	27.8	2.0	29.8	36.0	(20.3)	0.6	77.2
Other OECD	3.4	-0.4	3.0	4.0	(2.3)	0.2	85.0
Total OECD	**118.5**	**16.2**	**134.7**	**129.0**	**(72.9)**	**21.5**	**91.9**
Non-OECD				**48.0**	**(27.1)**		
World Total				177.0	(100.0)		

Source: OECD, "Globalization of Industrial Activities," (Paris:1992)

Notes: Production & estimated consumption: 1988

Trade: 1987. Exports & imports in Europe are those of EC only.

Figures in the parentheses show percent of world total.

Table 3-18 Production/Distribution Structure of Singapore's Chemical Industry

(Unit: million S$)

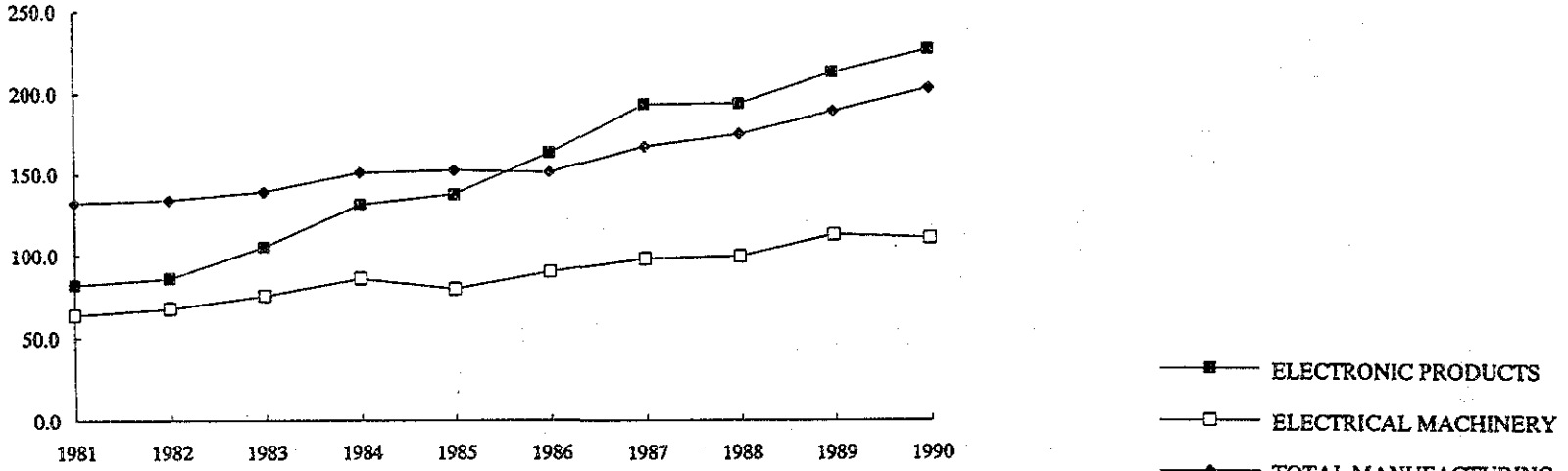
	Industrial Chemicals & Gas (Incl. Plastics) (A)	Paints & Pharmaceuticals (B)	Sub-total (C)=(A)+(B)	Plastic Products (D)	Sub-total (E)=(C)+(D)	Petroleum & Refinded Products (F)	Total (E)+(F)
Production							
1981	372	670	1,042	542	1,584	14,454	16,038
82	424	675	1,099	531	1,630	14,641	16,271
83	523	765	1,288	580	1,868	13,164	15,032
84	1,240	940	2,180	670	2,850	12,449	15,299
85	1,691	891	2,582	612	3,194	11,031	14,225
86	1,724	1,094	2,818	611	3,429	6,990	10,419
87	2,387	1,276	3,663	843	4,506	7,491	11,997
88	3,259	1,429	4,688	1,234	5,922	7,663	13,585
89	3,068	1,593	4,661	1,350	6,011	8,765	14,776
90	3,150 1)	1,772	4,922	1,428	6,350	11,364	17,714
91 p)	3,274	2,277	5,551	1,649	7,200	11,255	18,455
Annual Growth (%)							
1990/81			18.8		16.7	-3.6	1.1
Export							
1990	1,953 2)	1,482	3,435	292	3,727	6,334	10,061
91	4,428	1,198	5,626	285	5,911	17,192	23,103 3)
Import							
1991	3,833	1,220	5,053	630	5,683	16,040	21,723 4)

Notes: p) Preliminary
1) Industrial chemicals & gas: 1,888 ton
Plastics: 1,262
2) Industrial chemicals & gas: 933 ton
Plastics: 1,020
3) Singapore total exports: 101,878 ton
4) Singapore total imports: 114,191 ton

Source: Singapore Industrial Statistics

Fig. 3-1 Output/Value Added per Worker of Singapore Electronic & Electric Industry

(1) Output per Worker



(2) Value Added per Worker

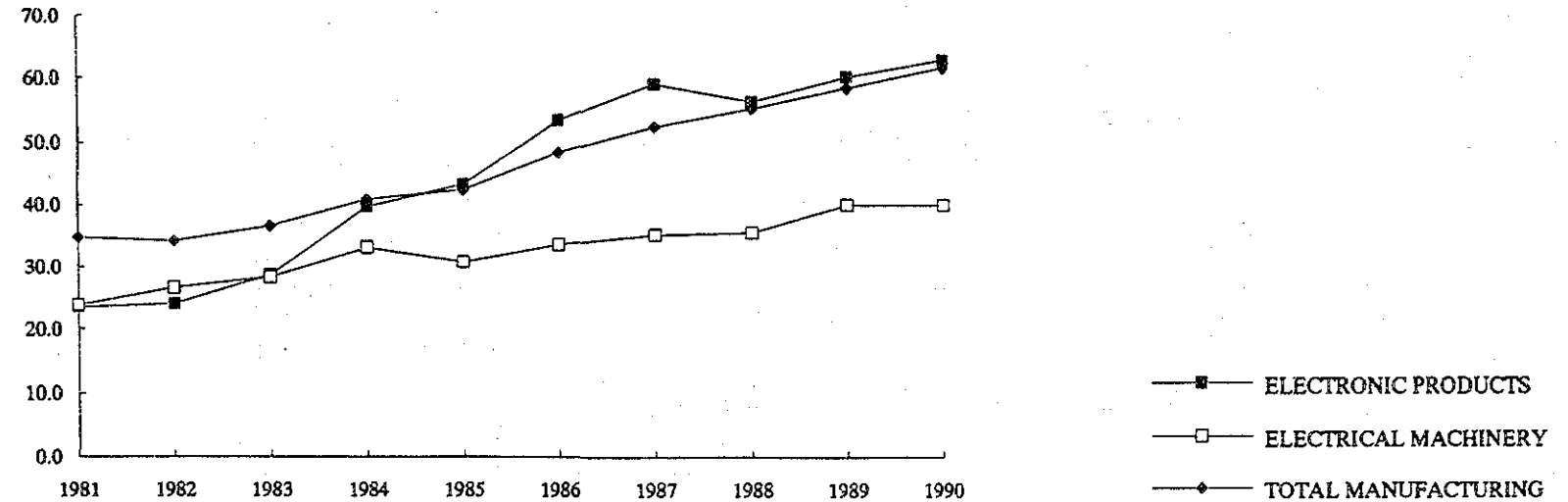


Fig. 3-2 Packaging Conditions and Expiration Dates of Nuts

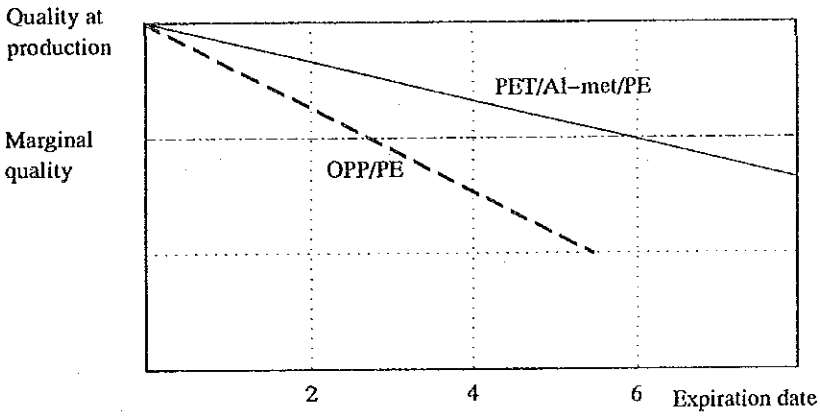
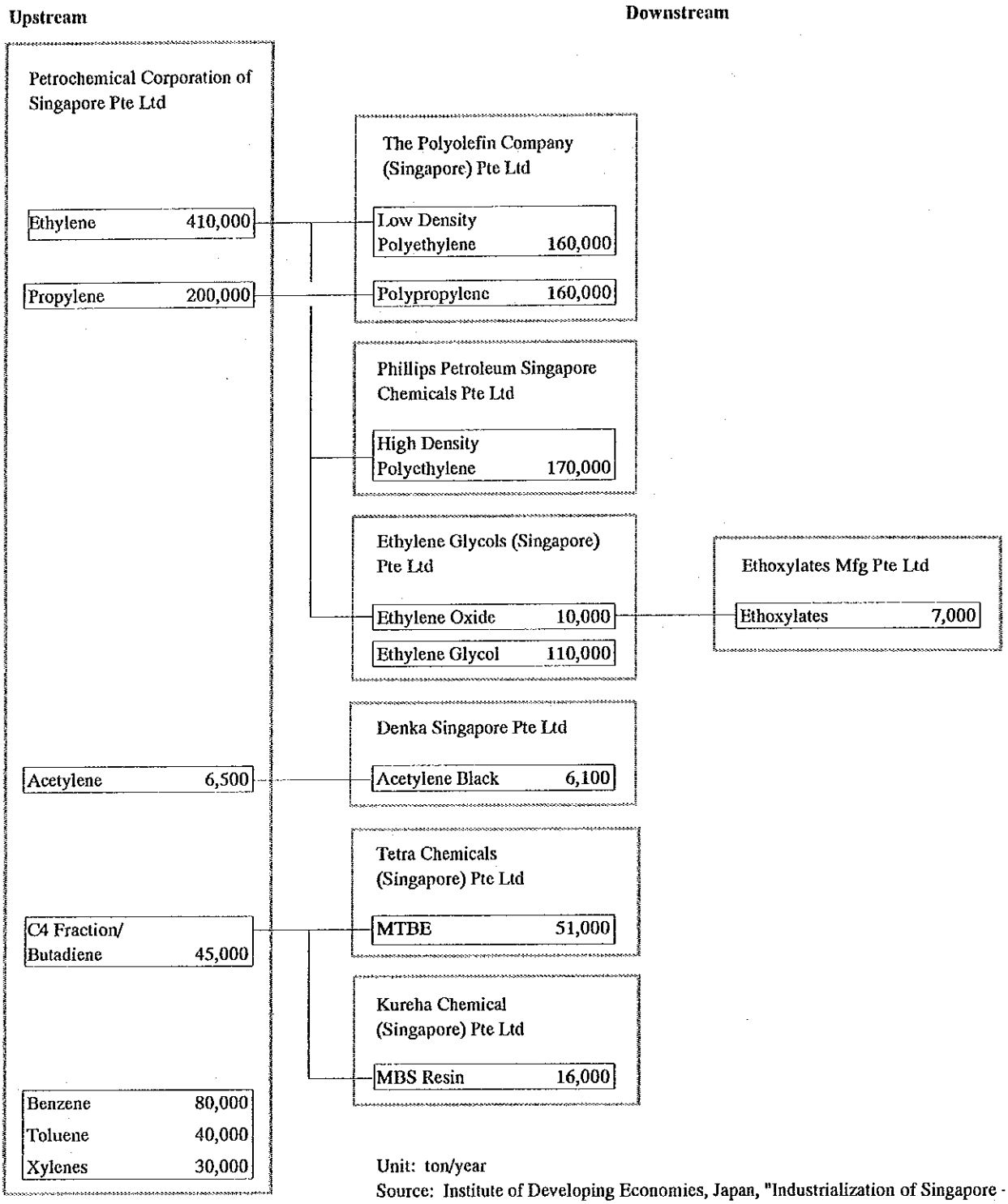


Fig.3-3 Outline of Singapore Petrochemical Complex



Unit: ton/year

Source: Institute of Developing Economies, Japan, "Industrialization of Singapore -

4. Present Conditions and Development Issues of the Packaging Industry in Singapore

This chapter analyzes the current situation of the packaging sector in Singapore to understand the issues which each sub-sector of the packaging industry has faced. In analyzing the industry's issues, the Study Team evaluated the quality of packaging materials in the market and packaging design capability through the tests of these materials using the testing equipment, in addition to the field survey on packaging industry and its user industries. The result of evaluation was reflected in this chapter with the detail included in Annex of this report.

4.1 Overview

4.1.1 Scale of the Industry and the Market

According to the EDB's[1] 1990 Industrial Census 187 companies in Singapore were engaged in production of packaging materials, and the total employment of 9,200 persons gives an average number of employees per company, 50, while the total value of production was about S$1.5 billion (Table 4-1). This value corresponds to 2.3% of Singapore's GNP. In industrialized countries, the ratio of packaging industry output to GNP averages about 2%, so the industry in Singapore resembles those nations by this measure of comparison. The average value added ratio of the Singaporean packaging industry (the ratio of its value added amount to the value of production) is 35.4%, that is higher than the average for Singaporean industry, 30.3%.

In Singapore's industrial statistics, packaging industry is not separated as a sub-sector in tabulations. In the Census, the industry is involved in the total of part of each of "Wood" (Industry Code 33121), part of "Paper (34120), "Plastic" (35713 and 35714), and "Metal" (38151 and 38159). Further, "packaging machinery" that constitutes a part of the packaging industry is not given a code number in the Census but is split into in some categories. The Packaging Council of Singapore does not appear to have comprehensive membership base as it has about 40 members whereas the number of packaging materials manufacturers or processors is reported to be about 200. The Council does not compile its own statistics. Because of these constraints, the Census was used as the best available source of data on the industry. In this report, references to the packaging industry of Singapore are to the industrial sub-sectors represented by the total of the above six code numbers.

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[1] EDB, "Industrial Census Report, 1990"

As is shown in Table 4–2 of the production value of S$1.5 billion, 72% or S$1.07 billion is shipped to domestic market, and the remaining S$400 million (28%) is exported to nearby countries. According to the Trade Development Board (TDB), an increase of 3 times was recorded for this category of exports during the period 1978–1988. Also, in view of the export ratio of Singapore's manufacturing sector, 65.5% of total output, which is estimated to be included an additional S$700 million worth of packaging is exported indirectly, with products exported . Therefore the industry has a total value of exports of about S$1.1 billion, or about 73% of production value.

Because domestic shipments of packaging materials have the nature of being industrial goods, more than half (55%) is sold directly to users. 40% of production is sold to wholesalers.

Table 4–3, based on Census data, shows product groupings in order of descending "packaging materials cost." Of the total packaging materials cost in manufacturing of S$1.06 billion, the food and beverage industries account for the most, with a share of 40.0%, followed by electric and electronic products, 22.1%, and chemicals, 20.2%. The share of the industry in the total manufacturing cost of packaging materials is 82.3%, indicating that these industries are Singapore's major users of packaging.

In more detail, the ratio of packaging materials to the value of shipments is highest in the case of beverages, at 32.3%, followed by tobacco products, 15.5%, and foodstuffs, 10.5%, indicating the higher packaging materials cost of the food and beverage industry compared to their product prices. The ratio is as low as 1% for electric and electronic products, reflecting the high price of those products. In the chemicals and pharmaceuticals industry the ratio is only 1.2% because of inclusion of petroleum refining products, while the "paints and pharmaceuticals" grouping, where products are closer to the final consumers, the ratio is nearly 4%.

4.1.2 Number of Packaging Companies

Table 4–4 shows PCS estimations of the number of packaging materials processing companies, and companies handling those products, by type of material and type of product.[2] The number differs from that given in the Census. It is thought that the accurate number of companies in this business is difficult to determine because of existence of many very small firms. Although the data shown here is considered to well represent conditions in the disaggregation by product group, there also would be some

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[2] SMA/PCS, "Singapore Packaging Industry Directory, 1990"

double counting in the tabulation of the number of companies. In the members directory of the PCS 180 companies in this industries are mentioned in the index.

According to the directory, it is estimated that there are more than 40 companies handling packaging machinery, suggesting that there is strong demand for such machinery. Further, although there are no glass container manufacturers in Singapore, the presence of seven importers shows that demand for these containers is high.

4.1.3 Factors Affecting Domestic Supply of Packaging Materials and their Conditions in Singapore

Packaging materials are either made according to standard specifications regarding dimensions and qualities of materials, or are made to order. In general, packaging materials used for shipping, with the exception of pallets and modularized cartons, general-use polyethylene bags and the like, are not standardized. Packaging materials that are not standardized are produced for packaging of specific items, and use the materials and have the dimensions required by the user. In such cases, the sales price to the users is based on the quantity ordered, production process, and number of operating steps. Therefore, it may be necessary, depending on the quantity required, to sacrifice a certain degree of some packaging functions for the sake of the overall package produced, or to use a standard, off-the-shelf, package. Manufacturers in Singapore are particularly liable to such restrictions, owing to the small scale of demand at a given firm. The present conditions of factors affecting the supply of packaging materials in Singapore are as follows:

1) As in the case of items of exported manufactures, that comprise 80% of total goods produced (for example, at the level of item of company A's type X cathode ray tube, or company B's 80-gr. package of snack food Z), the lot size of packaging materials ordered is relativcly large, in which case it is economically beneficial to use domestic products for which production lots attain minimum economic scale.
2) It is not possible to produce in Singapore packaging materials such as glass containers or large rolls of plastic film, where user-industry demand is not sufficient to enable minimum economical scale of production to be attained, even though the scale of orders may be large.
3) Even though it may be possible to gain assurance of orders of lots that can be produced in Singapore, if users' technical requirements such as regard to quality can not be met by domestic production, the packaging materials must be imported.

general purpose uses to the dimensions and characteristics of the product in question as well as selection of materials desired. The general-purpose packaging materials that are available in the market generally are limited with respect to the materials used and their form or shape, and tend to be high in cost.

The factors affecting the domestic supply of packaging materials and the present their supply situation can be seen in Singapore as follows with specific reference to production lots of major materials, manufacturing technology, and availability of raw materials. For many of these the production lot in Singapore is small and the potential for national production of packaging materials as has been accomplished in the West or in Japan is limited. To overcome this it is necessary to increase production lot size, but there is a limit to the increase in production possible on the basis of the domestic Singapore market alone, making exports the key.

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

4.2 Paper and Board Container Sector

4.2.1 Overview

The principal paper and board containers produced in Singapore comprise corrugated board, corrugated cartons, printed carton from coated board, wrapping paper, heavy duty bags, fiber drums and tubes, and paper cups.

The number of companies in the paper and board container sector is, according to the Industrial Census, 62. They have a value of production of about S$600 million, and account for about 40% of the total production value of the industry. More than 60% of the shipments on a value base is to domestic destinations, and 2/3 of that is sold directly to users. The remaining share of about 40% is exported to the ASEAN and other Southwest Asian countries.

4.2.2 Production

Facilities for manufacturing containers of paper and board are extremely diverse, and range from high-speed equipment capable of processing the paper material at the rate of several hundred sheets a minute to low-speed equipment that processes paper at several tens of sheets a minute.

In the case of Singapore, the scale of production of industries that use 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, so there has been a tendency for low-speed equipment to be employed. Moreover, because the existing arrangements can not cope with the demands of mass production, a restraint is imposed on expansion of the market.

The following outlines the situation of each product group.

(1) Corrugated board and corrugated cartons

There are 36 companies making CPPC and they have made a Corrugated Board and Carton Manufacturers' Association. Many of these are integrated producers, that make corrugated board, print it, die-cut it, and fabricate boxes of it.

There are six large makers of CPPC, 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, and they 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. Almost all of their printing equipment and box making equipment is of an old type. Often they have no inspection equipment or, if they have equipment, it is manually operated.

According to PCS, corrugated carton makers consume 140,000 tons a year of kraft liner and corrugated medium liner. The kraft is imported from North America, Australia, New Zealand and Sweden. Trade statistics show that in 1992, 108,000 tons of kraft liner and corrugated medium paper liner were imported (N.B. collection of these data was done on a different level than the data used to estimate consumption). There are two paper making companies in Singapore, and some imports from Malaysia where manufacturing was started a year ago.

The large makers follow specifications provided by the users, and use virgin kraft. In such cases, at times the user specifies the country of origin, producer, and grade. Some smaller companies, however, use board made from recycled board, that may, depending on the use, undergo deformation because of heavy loads or absorption of moisture, so that the function of protecting of the contents is not adequately provided.

The corrugators generally used for corrugated carton production comprise the single facer, that glues the corrugated paper (medium) and with a flat sheet of paper (liner); the double facer, that glues a flat sheet to both side of medium; the slitter scorer, for when corrugated board is to be folded to form boxes; and the trimming machine that cuts sheets. In Singapore, mostly machines imported from Japan are used.

There are some instances when gluing is performed using tapioca starch, made primarily from cassava, as opposed to the cornstarch base used in Japan. This material is imported from Thailand and has the merit of being low in price.

Carton manufacturer uses 1) a printing unit (flexo-printer), 2) a gluing unit, 3) a die-cutting unit and 4) a stitcher unit (using staples), but recently there has been a trend for using of machinery that performs more than one of these operations. In the case of Singapore, however, most of the large manufacturers are using separate units. At the large manufacturers cardboard and corrugated board processing and handling, and container-making equipment, are controlled by NC equipment and computers, so that dimensional accuracy is high and loss is low.

The capability of box-making equipment to be used for small-lot production is in general high, and standard-size paper is used. Therefore, there is virtually no difference in cost variation according to lot size except that related to cutting, and downtime cost. Therefore, the minimum economical production scale is several hundred, and it is easy for a nation to establish its own box making industry.

(2) Paper containers and boxes

Paper is widely used as the material for containers and boxes for foods, clothing, personal accessories and other products that must be individually packaged, because of the material's characteristics, 1) free of smell and hygienic, 2) suitability for printing, 3) high suitability for mass production and automated wrapping or packaging, 4) easy to recycle or dispose, and 5) potential for combination with non-paper materials. These products comprise the second largest market in Singapore after corrugated cartons and boxes.

The production process comprises using coated board, printing and surface processing of it, followed by die-cutting and box making. According to PCS, there are more than 50 makers in Singapore. Of these, more than 20 are engaged solely in printing boxes.

Annual consumption of coated board is on the order of 40,000 tons.

Generally orders for paper boxes are small in 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 in production processes, and product inventory which requires relatively large warehouse space. In major user countries recently, there has been a trend toward automation of machinery and equipment, reduction of labor requirements, and standardization. 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 MNC food companies, there are some instances of procurement of boxes from the home country.

In the case of cartons and shopping bags and the like, because fabrication, trimming, and so on are often protected by patents, we can see licensed production, and acquisition of foreign technology by businesses that make these products. Production by use of the carton system under license from overseas parties is used in general for high-speed production and high-speed cartoning, for which large systems are employed. In these cases, production lot units are several hundreds of thousands.

The largest company engaged in paper box fabrication has acquired technology for carton systems from the US, and uses coated board at the rate of 150 tons/month. This company has considered exporting its system cartons but in this case the lot size would be a million. For other cartons, designs have been acquired from abroad.

This company produces, in addition to cartons, carrying bags such as used at department stores and other establishments, and production is at the scale of more than S$10 million a year. Equipment it uses includes an offset printer of Japanese make, three imported two-color printers, a die-cutting machine and a box fabricating machine, both imported. Much of the work, however, is performed manually.

(3) Paper bags and wrapping paper

According to PCS there are 20 makers of paper bags, and more than 200 companies that print on paper bags. Many of their products are used by tourists visiting Singapore, to take home purchases made there.

High-speed machines have been acquired for production, but 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.

(4) Heavy-duty sacks

Makers of heavy-duty sacks made of two-ply laminated papers such as paper and polyethylene film, or woven bags made of polypropylene number five, according to PCS. Their products are used for cement, flour, feed, plastic pellets, powdered chemicals and other commodities.

(5) Fiber drums, tubes, cones

According to PCS there is one fiber drum maker, and two tube makers. One of the tube makers, however, is also a fiber drum maker. Each of the three companies has acquired its technology from the US or Japan.

Fiber drums had been used for dry chemicals in the past, but have been replaced in this usage by steel drums and heavy-duty sacks, with a resultant decline in demand. Tubes are used for the core for winding paper or film, and cones are exported for use in the textile industry of nearby countries such as Malaysia and Indonesia.

4.2.3 Market

There are no statistics on demand in Singapore for paper and board containers by type of use. On the basis of responses to the questionnaire survey conducted by SISIR[3] and the pattern of demand by type of use or user-industry in Japan, in quantitative terms the

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[3] LNE (Laboratoire National d'Essais, France), "The SISIR Packaging Centre (Techno-economical and Feasibility Study)" (1991)

greatest portion of demand is in the food products industry, followed by the electric and electronic products industry, chemicals and pharmaceuticals in that order.

4.2.4 Operation

According to the Industrial Census, the 62 companies in the paper and board products sector employ a total of 3,105 persons, or an average of 50. The per-company scale of employment is about the same as that for the packaging industry overall, but about half of the average for all manufacturing, 95.

Shipments per employee were S$190,000, or slightly higher than the packaging industry average, and about the same as that of all manufacturing. In contrast to this, value added per employee, at S$84,000, is the highest in the packaging industry and more than 30% higher than the all-manufacturing average, clearly showing that this is a high value-added sector.

Wages and salaries per employee were S$22,000, slightly above the average for the packaging industry and all manufacturing.

According to PCS, there is some unutilized capacity in the corrugated board and corrugated carton industry, and, moreover, about 10% of the production value is being exported to the Mideast and Pacific region.

The value of production equipment in the industry is not known, but the depreciation value per company is less than that of all manufacturing, and higher than that of the packaging industry.

4.2.5 Issues

Current issues in the paper and board container sector are primarily concerned with corrugated cartons, as they have the major role as shipping containers.

(1) Issues related to quality of packaging materials

1) Buckling of corrugated cartons as a result of absorption of moisture, and vibration

Buckling of corrugated cartons is seen as a result of the combination of the properties of the paper materials, the climatic conditions in Singapore (mainly the high level of humidity) and the vibration during shipping, especially by maritime vessels. Resolving this problem has become more urgent in keeping with the increase in the precision of products being shipped, and the increase in their value.

Because the major reasons are the climatic conditions in Singapore, and the particular features of the shipping process for goods from Singapore, it is necessary that countermeasures be developed by Singapore. These are not problems for the corrugated carton industry to solve by itself, as it is necessary that there be participation in the effort by user industries and companies that are involved in physical transport and storage of the containers holding the commodities.

It will be necessary for the packaging industry to act on the results of that effort, by taking such steps as adding plastic or other materials to the kraft or liner used for cartons, by reducing hygroscopicity, by making stronger cartons, by making the construction of cartons stronger, by changing the distribution of product weight in the containers, and other, inter-related, measures. In conjunction with this, it will be necessary to consider improving the board manufacturing technology in Singapore, raising quality standards, and give due attention to allowable increases in the cost of manufacturing cartons.

2) Improvement of the quality of corrugated board

There are 36 companies making corrugated cartons in Singapore. The larger companies among them are thorough-going in their quality control activities, in addition to which SISIR has authority to certify that ISO standards are being met, and the confidence of the user companies, notably among the MNCs, has been earned. In comparison to this, the medium and small scale makers include some that seek to obtain business on the strength of price, not quality, and products from such firms have been known to buckle, collapse when stacking, rupture, or have printing that is not in register. This type of defects damages not only reliability of corrugated cartons, but also damages the reputation of Singapore products in the cartons.

In order to increase the reliability of domestically produced corrugated cartons, it is necessary to improve the industrial standards for corrugated cartons, and on that basis to promote greater efforts at assurance of quality. Adoption of an industrial certification scheme is believed to be of value in this connection.

3) Upgrading of printing technology for corrugated board

The major function of corrugated cardboard cartons used to be the protection of the commodities, but in keeping with change in modes of distribution, there has been an increase in the placement of those cartons in retail stores where consumers can see them. In order to improve displaying efficiency in the stores, makers of electric and electronic goods, of food products, and others have made much use of colorful printing on the cartons.

In keeping with this increase and change of demands for printing carton, it has become necessary for companies in the carton business to prevent thickening of lines in plate of flexography printing (that is now the most widely used carton printing process), broaden the range of inks that can be used, development by means of applying film printed by the gravure process to the surface of cartons, and make technical improvements in such areas as automation of printing plate-making, while it has also become necessary to collect information on computer-aided design for printing.

(2) Efforts for joint development with user industries to improve the quality of packaging materials

1) Cooperation for reduction of shipping cost by improving shock absorptive materials

There are standards for ocean and air cargo containers, and owners of the goods in shipment must pay for shipping certain volumes even if there are voids in the containers. Shipping distances to American, Japanese or EC markets are great, and the cost of shipping is relatively high. It is therefore an important point for Singapore's manufacturing industry to maintain price competitiveness by reducing dead space. It is necessary that the corrugated carton industry provide strong cooperation for efforts by the user industries to develop package design methods that minimize requirements for shock-absorptive materials while still providing adequate protection for the goods.

2) Study of optimum containers for a diversified modes of distribution

The modes and methods in the process of distribution (shipment etc. from point of production to the ultimate user) are diverse, to include ships, aircraft, trains, trucks, forklifts, and manual handling, in addition to which there are bulk shipments and shipments of individual products. The quests for the optimum container and packaging that complies with this situation involves more than rationalization of the goods distribution process, reduction of distribution costs, insuring protection of the goods, and minimizing container and packaging cost, but also involves product design. Singapore's manufacturers are expected to proceed in this direction, of total optimization, making it all the more important for the corrugated board industry to develop its own products that comply with what the manufacturers do.

(3) Measures related to the environment

1) Diffusion of production technology meeting requirements of recycling

To some extent used corrugated cartons are collected in Singapore and recycled to make liner board, and thereby reused for carton production, but the quality of cartons made from recycled materials is not stable, owing to inadequate control of the

production process. Need to recycle corrugated board will increase in the future, making it indispensable that there be greater diffusion of proper production technology and production control techniques.

In technical terms, what is necessary is maintaining the proper ratio of the combination of recycled board and paper with virgin pulp, improving ink-removal technology, use of paper strengtheners, and improving quality control at manufacturers of liner and board, as well as other measures. These measures are operational in Japan and other industrially advanced nations.

2) Environmental measures in importer countries

Most of the corrugated board produced in Singapore is exported, by direct or indirect means. Many of the destination countries have already adopted or are studying measures for protection of the environment and efficient use of resources, making it necessary to consider those measures in setting specifications for corrugated board and containers made in Singapore. It is necessary that Singapore collect information from abroad in order to do this.

4.3 Metal Container Sector

4.3.1 Overview

The majority of metal containers made in Singapore are cans for food packing, drum cans, pail cans and composite cans.

The number of metal container makers according to the Industrial Census is 23; the value of their production is about S$440 million, and they account for 30% of the total value of production of the packaging industry.

The Census separates metal containers into cans for packing food and other metal containers. The share of shipments of the former segment to the domestic market is more than 80%, the remainder being exported to nearby countries. In contrast to this, as much as 96% of the production of the non-food metal containers is for the domestic market and almost all is shipped directly to users.

4.3.2 Production

Production status of containers by product group is described below.

(1) Metal containers

During a recent 5-years period, according to PCS, demand for metal containers grew constantly, in keeping with the increase in exports of foods and beverages produced in the country.

There are 12 makers of metal containers, who make a variety of decorated cans, or export printed can metal sheets or can parts. Two large companies are the sector's leaders, and produce all kinds of metal container. One of them also makes aluminum cans for beer and soft drinks.

These companies use 80,000 tons of tin plate sheet imported from Japan, Rep. of Korea, Taiwan and elsewhere.

Metal cans, generally, are made of a lid, a body and a bottom and hence are called "three-piece cans," or are made of a body and a lid, and are called "two-piece cans." Three-piece cans are made of thicker metal to be strong, for packing of most foods that are hot when packed into the cans, that hold a vacuum. Two-piece cans, made of steel or aluminum and capable of being deeply drawn, have been in use since the latter half of the 1960s, and whereas they are made with less metal, because the wall of the cans are thin and weak, they are used for beer and carbonated beverages and the like when internal pressure helps the can to retain its shape. On the basis of constant efforts to make technological improvements of the three-piece can, engineers have developed the soldered-seam can, the cemented-seam can, the welded-seam can and tin-free steel. The major objective in the current effort at quality improvement of three-piece cans is concentrated on reducing the thickness of the side seam (presently twice the thickness of the rest of the body), and making it possible to more easily affix the lid. These improvements would better insure that leakage does not occur. Technology has also made progress in the case of the two-piece can, and the draw and re-draw can and the draw and ironing can have been developed. Whereas three-piece cans are produced through batch work, the two-piece draw and iron can is made in a continuous, integrated process, that is more suitable to mass production.

"Easy-open" (pull-tab) lids have been developed for beverage cans, but the pull-open type (detachable tab) has been identified as a source of environmental pollution, leading to development of and partial replacement by the "stay-on" tab type.

Metal container makers in Singapore have acquired ability to use these 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. In Singapore there have been instances of leakage of the contents from the sealing part of the lid of three-piece cans.

Manufacturing lines for cans for foods and beverages operate at speeds of several hundred a minute and the equipment has very high capacity.

Cans for foods are made to specifications or standards adopted for the specific foods and users can make almost no other requirement than the printing on the cans. But because costs rise when production lots of printed cans are small, such cans are used only by a few packers, and most cans are shipped plain. The standard can in Singapore is one that has a label glued to a plain body.

All beverage cans are printed as part of the production process, and because production lots are larger than those of foods there are no problems related to printing.

The only aluminum can maker in Singapore supplies all of the cans used for beer, all of the cans used for carbonated beverages, and 90% of the cans used for noncarbonated beverages, and is engaged in exporting as well. The company possesses three lines of Soudronic machines for making three-piece can bodies, seven lines of 330ml aluminum easy-open lid making Minster machines and two lines of Mailander 122 machines for printing on can bodies.

Speed of production of three-piece can bodies, using the Soudronic machine, is 400/minute while in the case of two-piece cans speeds are 800/minute for steel and 1,000/minute for aluminum. This company obtains technological support from its parent, an English firm. The company is, however, a subsidiary of the parent's Asian regional subsidiary. For it to be able to export more, it would be necessary to make cans having capacities different from those now made, having different neck bottom forms, have walls of different thickness, change the method of printing, and make other changes to match marketing requirements abroad. This would require acquisition of new dies and mandrels, new drawing machines and new printing equipment, and thus is not necessarily an easy move.

A high level of quality control is ordinarily required for production of cans for beverages, and this is not a product for which a company can increase business solely on the basis of price.

(2) Drums and pail cans

There are four makers of metal drums, who produce 2,600,000 240-liter drums a year. Five companies make pail cans, the largest can they make holds 25 liters.

Metal sheet on the order of 50,000 tons/year is imported by them, mainly from Japan, Rep. of Korea, Taiwan.

Almost all of these companies originally were users of cans, for edible oil, lubricant, paints and ink. At present they consume a large share of their own production, and some of the companies sell their products to other users. Up to 96% of production is for domestic shipment of which more than 87% is shipped directly to the users. Although only about 4% of production is exported, demand for drums and pail cans in adjacent countries is high. Domestic demand is very strong. As one result, there are 10 companies that handle recycled drums and pail cans.

The technology for manufacturing drums and pail cans is well established in Singapore, and each producer has a technical agreement with foreign companies for epoxy coating, or special linings such as using nylon.

(3) Aluminum foil

There is no domestic production of aluminum foil; all requirements are imported from Japan, Australia or elsewhere. This foil is used for wrapping cigarettes, household (kitchen) use, trays for take-home foods, and lamination with plastic film for packaging of foods, chemicals and pharmaceuticals.

4.3.3 Market

By far the most important use of metal containers is for packing food, in addition to which there is some use for wax, paints and chemical products for household use.

The two major uses of drums and pail cans are for liquid chemicals such as lubricants, paints and inks, and edible oils such as palm oil, coconut oil and so on. A major use in the past was for shipping chemicals, but recent construction of chemical tankers has enabled an increasing number of companies to switch from drums to those vessels, creating a large-margin decline in demand for that use.

4.3.4 Operation

According to the Industrial Census, there are 2,500 persons employed in the metal container sector, for an average of 108 per company. This is somewhat higher than the average of 95 for all manufacturing. If only metal can makers are taken up, the average

per company is 160 employees, making this the largest sub-sector in the packaging industry, by this measure.

Shipments per employee are valued at S$176,000, that is somewhat higher than the average for the packaging industry, and at about the same level as that of all manufacturing. The value added per employee, however, is S$48,000, which is relatively low for the packaging industry. The average wages and salaries per employee is S$21,000, which is slightly higher than the average.

Equipment investment in this sector is at a high level. The total amount of investment is not known, but the value of depreciation per company is 1.6-times greater than that for all manufacturing, and more than triple that for the packaging industry. This is thought to reflect investment in technological innovation, such as for the two-piece cans as described above.

4.3.5 Issues

(1) Upgrading of technical capability through co-works with packaging users on trouble shooting

Regarding cans for packing food, that comprise the most important part of the metal containers sector products, the sealing of the cans is performed by the food packer. When a technical problem has been identified, therefore, its cause must be determined through cooperative action by both the can maker and the user. Whether the above-mentioned problem of the sealing of lids of three-piece cans is a matter of the structure of the entire can, or of the manner of use of sealing machinery, deserves full study. There are many small companies among the food packers, and many of these companies tend to lack the ability to perform technical analyses of problems such as this. In particular, problems such as the cause of leakage from the sealing (seaming) part of a can are less frequently improper fabrication of the can itself than handling in the transportation of empty can (from can manufacturer to users), inadequate maintenance of the seaming equipment, or inadequate operation of the equipment, and regarding these causes there is need for an organization of some kind to make a specialized educational effort or the supply of information by makers of metal containers, or a public body.

(2) Measures for environmental protection

About 60% of metal containers used in Singapore are recovered; this is the highest level in the world. Firms that specialize in collecting used metal containers obtain waste metal after trash is incinerated, and sell it to steel mills. Because only steel cans are now in circulation it is a relatively simple matter to recycle cans in this way. But in the future

it is certain that aluminum cans will also be collected, together with the steel ones. It is necessary to establish, in advance, a means of separate collection of them prior to recycling.

It is necessary to print on cans that are exported the proper wording required in the destination country or countries regarding disposal and recycling of the can. For this purpose it is necessary to start collecting information from abroad.

4.4 Plastic Container Sector

4.4.1 Overview

The major plastic containers produced in Singapore are polyethylene film bags, multi-ply laminated film material, blow-molded containers, injection-molded containers, vacuum-formed containers, and foamed cushioning materials.

Raw materials for these include polyethylene, polypropylene and polyvinyl chloride produced in Singapore, and a variety of imported plastics. Of the four major plastics, Singapore relies on imports for polystyrene.

The number of companies engaged in making electric and electronic parts, building materials, housewares and so on from plastics, according to the Industrial Census, is 285, and of then 86 are seen as being producers of packaging materials. The value of production by the latter is about S$410 million, so similar to the metal containers sector it accounts for about 30% of the packaging industry total.

4.4.2 Production

Production equipment used to make plastic packaging materials, by including both equipment for working with flexible materials such as laminated film, and rigid materials such as injection-blow-molded bottles, is either general-purpose, or suited to making specific size lots. Equipment for putting together the materials to be laminated, and the slitter that does the cutting, are general purpose in nature, but the equipment creates a limitation on the product, by having a maximum width, and to this extent there is a limit on the lot produced. On the other hand, the equipment used to work with rigid materials can accommodate demand for a wide variety of forms of the finished product, by changing of molds, but there are limitations to the speed of production and the various uses of different materials, in addition to cost restrictions. Concerning these points, the characteristics of the different materials in use are discussed below.

Among the flexible packaging materials, in the case of non-laminated shrink film, and bags, the size of the production lot is determined by the speed and the width of the printing equipment, slitter, and bag making equipment. In general, in the case of this kind of material, the film length of several thousand meters is processed as a single unit, and this corresponds to the lot size of several tens of thousands of shrink labels and bags. If the production lot is to be smaller than this, the ratio of fixed costs, securing the starting roll of film, and downtime costs rise as percentages of total cost, to the extent that they can eventually push the total cost beyond the acceptable limit. In cases such as this, either a change in the method of packaging or the use of general-purpose materials would have to be studied.

Among the group of flexible packaging materials, the width of the laminating equipment determines the scale of the lot size, but with a difference based on whether or not printing is required. In order to process film that is narrower than the standard processing width of a laminator, a considerable increase arises in the time required for preparation, and stocking of parts, and also the processing is often not possible because of conditions imposed by the laminating. Problems are likely to arise in particular when printed film is to be processed, and if broad-width materials are employed in order to match lot size to the conditions imposed by the processing machinery, it will be necessary to carry a much greater inventory of finished-product packaging materials than is needed, resulting in diseconomies. The production lot of a laminator is the several thousand meters length of the film. When the production lot is to be smaller than this, the percentage of the film that is used for preparation for production, with the likely result that conditions for use of the laminator are not all assured, costs rise and stability of quality is endangered.

Among rigid materials, materials that are processed to make blow bottles, trays, cups and the like are often made to standard specifications in Singapore. In such cases, the identity of different products is provided through differentiation using labels and surface finishing. The capacity of the forming equipment used is determined by the scale of the market for its products and in Singapore is influenced by change and the level of exports to adjacent countries (true for both containers and finished goods).

In the case of plastic containers supplied for single user, it is conventional for the user to purchase the molds. Therefore, it is necessary to only study the economics of equipment capacity by taking into account running cost and the necessary cost of downtime for preparation. When coloration materials are used, and need arise to change from one color in use to another, it is necessary to use some new resin to force old resin out of the equipment, to thereby insure that old coloring will not be carry into the new and

when a special resin is used a similar practice is necessary to prevent contamination with a different kind of resin. For these reasons, the downtime cost, a fixed cost, becomes high in terms of its ratio to the total, and this tends to force unit costs up.

One large converter of flexible packaging materials possesses one 800mm-width 6-color printer (imported) and a set of Helio plate-making equipment for gravure printing on film. In Japan, printing in 8 or 9 colors and with a machine having 1,300mm width is common, and the minimum economic scale at this company compared to the situation in Japan in terms of machine width is 2/3 that of Japan. Regarding laminators, the company has one Japanese-made 1,000mm die width extrusion laminator, and 6 or 7 slitters. He uses 3 bag manufacturing machines imported from Japan. These machines are used to make pillow type or square bags, with the line speed of 80 bags/minute.

The following is a description of the production conditions for each product group.

(1) 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.

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 at least a certain strength, and there are no special technical problems. More than half of production is exported to adjacent countries. The sales price of bags for both export and the domestic market is low.

Because bags for industrial use must satisfy waterproof and rust-preventive requirements, it is necessary that products be `checked for pinholes and faulty seams.

(2) Multi-ply film

In general, multi-ply film is made by bonding (laminating) two or more types of film (and/or paper, aluminum foil, or other materials) so as to acquire a material that has properties not available from a single type of film alone, and can be used for a multiplicity of purposes. In Singapore there are seven companies engaged in making this kind of film. Both of two methods are in use there, dry lamination whereby an adhesive is used between films, and extrusion lamination whereby melted polyethylene is used as a binder.

Table 4-5 gives the general constitution of the major multi-ply films in production, and examples of their uses. Among them, OPP (oriented polypropylene) is the most used, as it is suited for food packaging, cigarette packs, the base for transparent adhesive tape and other uses.

In Singapore, retort pouches for food have been recently identified as a promising demand area for multi-ply film. In selecting the film materials to be used and manner whereby they are to be combines for use in making retort pouches, it is necessary to take into consideration many factors, such as the safety and hygiene of the packaging materials, and their not imparting any small or taste to the food, as the most basic requirements, as well as to not delaminate when the pouch is treated to sterilize microorganisms, and to be suitable for printing to enhance commercial appeal of the product, to be resistant to formation of pinholes as a major means of insuring protection of pouch contents, to resist to cold temperatures, to not rupture if dropped, to be capable of being sealed, to function as a barrier to oils, gases and moisture, to maintain aroma, to have a low enough coefficient of friction so as to be capable of being processed at the rate of several thousands of pouches an hour, and to have a dimensional stability on thermal shrinking property.

Further, problems can easily arise when new materials are used for lamination with other materials and undergo processing. For example, when PET (polyethylene terephthalate) film or nylon film is used there is a tendency for the laminate to have insufficient strength, for heat seals to be under required strength levels, and for there to be trouble related to use in low-temperature environments (as in the case of frozen foods). Also, it is necessary to give attention to the problem or potential problem of air pollution caused by use of organic solvents at the time of laminating, and of the laminated material's acquiring a smell from residual solvent.

(3) Other films

The quantities of stretch film, shrink film and anti-static film used in Singapore are increasing but there is little domestic production, so the remainder of demand is met by imports. Demand for anti-static protective packs is increasing owing to the growth of the electronics industry's use of printed circuit boards.

(4) Blow-molded containers

According to PCS, there are now more than ten blow-molding companies in business in Singapore, that use polyethylene, polyvinyl chloride, PET and other

materials to make bottles, jelly cans, drum cans and other products, that are used for pharmaceuticals, edible oils, soft drinks, lubricants and other products.

In general the process of blow molding, that makes use of a method similar to that of glassblowing,is used to make plastic bottles and tubes. Thermoplastic is heated until it melts, is extruded in a pipe shape (this is called "parison") into a mold, and air is blown in so that the molten plastic is forced against the wall of the mold. The mold is cooled, permitting removal of the newly formed bottle. Techniques that have been developed, in addition to the tradition method as described here, are extrusion blow molding (that gives high-precision apertures in the formed product, does not leave flash, does not require finishing, can be used to make thin-wall containers, and can be used to make wide-mouth vessels), and draw blow molding (PET or other resins are brought to above the glass, transition point and drawn at a temperature below melting to increase its strength). Another technique that has been developed in order to provide gas barrier and heat-resistant qualities in blow molding is to blend different plastics or to make a multi-layer wall similar to the method used for multi-ply film.

Because uses of blow-molded products include containing liquids, pinholes, cracks or unevenness at the aperture caused in molding process would lead to leakage. Such defects can be seen in Singapore.

(5) Injection-molded containers

According to PCS, there are more than 30 injection-molding companies in Singapore who produce plastic crates and pallets to carry beer bottles, variety of industrial containers, pails and drums for chemicals.

In injection molding thermoplastics are heated to melting, forced (this is called "injection") in liquid form, under pressure, into a mold that is then cooled so that the plastic solidifies, and is removed. In general, the cost of molds is high because they are large. In the industry, this high cost has resulted in makers of the products to make molds for large-lot orders such as for crates and pallets according to the specifications and standards of the customer, while using general-purpose molds for small-lot runs of products such as pail cans, and drum cans for industrial use. The technology used for injection molding is essentially mature and the areas left for further technical development are precision improvement and automation.

(6) Vacuum formed containers

According to PCS, there are about 10 vacuum forming companies, who process polystyrene sheet, foamed polystyrene sheet, polypropylene sheet and polyvinyl chloride sheet, to various kinds of trays.

The trays are mostly for one-way use in fresh food packaging, so the materials are required to keep their intended properties or to function for only a short time. After being opened at home, almost all of these are thrown away. On the wrapping an indication is provided of the freshness or shelf life of the food and most of the time is short. For this reason it is essential that they should be produced at low cost. On the other hand, it is also required that the tray appear attractive on the shelf at the retail outlet. It is not acceptable if, for example, the food on the tray shifts from the center to one side while it is being shipped to the retailer. For that reason, efforts made include cutting the food so that it fits the tray, or cutting it so that there is a small protuberance (without increasing costs), but these techniques are not in use in Singapore.

(7) Foamed shock absorbent material

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

EPS is made by expanding "beads" of polystyrene which is produced by blending the resin with a foaming agent so as to make the desired-shape form or block in a mold. The form or block is in some cases glued to the walls of a carton, and this material is commonly used for packing electric and electronic products. Domestic supply of beads is available from only one foreign-affiliated company, and also imported from Germany. Polystyrene foam is also used as a heat insulation material by the building materials industry, where good use can be made of recycled material.

In the case of EPE, too, beads are used; they are imported from Japan. From the viewpoint of protection of the goods, EPE is superior to EPS in shock absorbency. The beads, however, are 6-10 times higher in price than those for EPS, so that use of EPE is limited to providing protection for very expensive products, such as computer disk drives.

Polyurethane foam is used to make pillow and cushion filling and its use as a shock absorbent agent is extremely limited.

Shock absorbing characteristics of these materials differs according to the materials used, the expansion ratio or density, form or shape, area, thickness, and so on. In

designing shock absorbing materials it is necessary to give consideration to the specific requirements for protecting the product in question and it is essential that optimal absorbency conditions be determined. In Singapore, however, there has been almost no collection of data from experiences of this kind.

4.4.3 Market

Film bags are used as shopping bags.

Multi-ply film is used in Singapore almost exclusively for snack foods, boiled foods, retort pouches and other food packaging.

In the case of blow-molded containers, plastic bottles are used for soy sauce and other flavorings, edible oils and soft drinks, while jelly cans and drum cans are used for chemicals and lubricants.

Concerning the uses of injection-molded containers, in addition to use in the food products area for bottle crates, pallets are widely used within industry at production sites, in warehouses, and elsewhere, pail cans and drum cans are used for chemicals as well as for general uses at diverse manufacturing production sites and for packaging. In addition, as general industrial containers they are used at many industrial plants.

Vacuum-formed containers such as trays and cups and the like, are used for food packaging. The use of thin-wall containers for yogurt, margarine and other foods, although seen in many countries, is not common in Singapore. The reason is that the molds are costly, and manufacturers can not justify them unless there is a high level of demand. Thick-walled vacuum-formed products are used for movable containers at manufacturing facilities in the electric and electronics industry and for holding a multiple number of products for shipping.

Shock absorbing materials are mostly used for shipping containers and packaging in the electronics industry. There is strong demand, in addition, of polystyrene foam and polyurethane foam, foam in the building materials industry.

4.4.4 Operation

The 86 companies in the plastic container industry employ about 3,200 persons, for an average of 37 per company. Thus, the average company is relatively small in scale.

Shipments per employee were S$129,000, or about 80% of the packaging industry average and 65% of the all-manufacturing average.

Value added per employee was S$42,000 making this sector the lowest in the packaging industry. Wages and salaries per employee was S$17,000, somewhat lower than the packaging industry and manufacturing as a whole.

Plastic containers is separated into two groups in the Industrial Census, "plastic sheet, film and bags," and "plastic bottles, boxes and containers."

Nearly 45% of the output of the makers of "plastic sheet, film and bags" is exported to nearby countries, and 60% is shipped through domestic wholesalers and retailers. The value added ratio in this sector, at the 28% level, is low compared to the other sectors in the packaging industry.

In contrast to this, in the "plastic bottles, boxes and vessels" sector the value added ratio is at the 40% level, and is second-highest after the paper and cardboard container sector. Of total shipments, 94% has a domestic destination and 70% is sold via wholesalers and retailers. 30% is shipped directly to users,; this ratio is about half of the packaging materials average, indicating that the users are diverse and many in number, and that the average transaction is small.

4.4.5 Issues

Plastic container manufacturing in Singapore is relatively new to the country compared to containers made of other materials. But because it was relatively easy for 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.

(1) Improvement of packaging material quality

1) Improvement of plastic film printability

Printing on polyethylene and PET, and some other plastics, does not work well. In industrially advanced countries, however, improvement of printing inks has enabled this problem to be overcome, and advances have been made in development of laminates of various materials with easily-printed paper, surface processing of film, and anchor coating agents.

2) Prevention of delamination

Multi-layer film, by being made through lamination of two or more plastic films, acquires moisture resistance, gas impermeability, heat resistance and other functionalities not available when a single-ply film is used; this expands the applications of plastic film. But when PET film, nylon film, or other relatively new materials are used to make multi-ply film, peering of the layers (delamination) due to inadequate lamination sometimes occurs. The reason for this is that the manufacturers

have not acquired a proper understanding of the qualities of these new materials. These manufacturers must accumulate know-how for processing technology by acquiring suitable knowledge of the characteristics of each type of film, the varieties of binders and anchor coats that are available and their properties, and laminating conditions (processing temperature, speed, pressure, etc.), and carry out their own research. Further, what is involved is not merely solving the problem by using the right binder or anchor coating agents. These materials are costly, and study is necessary as to how Singapore companies can absorb this higher cost.

3) Elimination of pinholes and cracks in blow-molded containers

The most likely causes of these two problems would be short of mixing of the plastic materials and pigments, plasticizer and fillers; need exists to check on the mixture process. Technologically, this is not a difficult problem to solve.

4) Leakage caused by uneven aperture of blow-molded containers

This is a problem particularly found in Singapore, where traditional extrusion blow-molding process is now in general use. It can be eliminated by use of the injection blow-molding process developed for forming PET bottles. There must be sufficient demand, however, for this type of PET bottles for this to be adopted.

It is conceivable that for the time being the problem can be solved by improving the conventional blow-molding process through switching to polyethylene, a softer material, by inserting a sealing material inside of the cap. These are not difficult in technological terms.

(2) Cooperation for solving technical problems faced by users

- Issues related to heat seal technology

The final process in which plastic containers are used for packaging of food is performed by the user, namely the food maker or packer. When plastic film is used, if the heat seal is not well formed and does not function as intended, in some cases the package contents leak out, or moisture enters the package.

It is necessary to conduct many studies, and accumulate know-how so that the optimum arrangements can be made regarding the three vital aspects of the heat seal process, namely sealing temperature (melting temperature of the film material), sealing pressure, and duration time. Problems caused by inadequacies of these aspects tend to occur in small packing firms, where there are shortages of both qualified personnel who can undertake technical investigations and develop corrective measures, and interest in

such activities. It would be necessary for both public agencies and the packaging industry to provide support where it is needed along these lines.

(3) Research on new, optimal application of materials, and diffusion of packaging technology

1) Development of technology on packaging materials for retort processing

In order to make use of the potential of retort pouch packaging, it is necessary to provide not only for development work by food companies, but also for comprehensive research on disposal of the pouches after they have been used. This is not an R&D effort for the food companies to undertake alone, but requires the participation and support of packaging companies as well.

2) R&D of laminating technology on multi-ply film

Because of the high temperatures in Singapore, after foods have been packaged they are transferred to a "cold chain" and kept chilled or frozen. When they are purchased by consumers, they are returned to normal temperatures then boiled or cooked at boiling temperature (80-100 degrees C) or in a microwave oven (100-135 degrees C). Therefore packaging materials have to withstand the wide temperature range, and they must also provide properties such as moisture permeability, gas barrier, oil resistance and resistance to the contents as well. Many technical considerations are necessary to provide proper selection and combination of the film used.

Laminating technology of the multi-ply film, however, has applications outside of the food industry and have potentials of applications for flexible printed circuit boards, plane-formed heating device and diversified materials for high-tech industry.

3) Putting compartment and partitions to vacuum-formed trays

In order to prevent the losing of appeal on display by shifting of food during transport and handling, compartments or partitions are formed to fix the contents in position. Seafood processing companies and others that ship to supermarkets have strongly desired such measures be taken, but in Singapore thus far there has been no action on this point.

Technically, the prerequisites for this are 1) a precise mold manufacturing technology, and 2) improvement of the precision of good processing equipment. Neither is difficult to accomplish. The major constraints are on the level of demands such as difficulty to justify the expenditure of a mold for a small manufacturing lot.

4) Collection of data on shock absorbance performance of foamed cushioning materials

Foam type shock absorbent materials in use in Singapore are expanded polystyrene (EPS), expanded polyethylene (EPE), and polyurethane foam (PUF). The shock absorbency of these differ according to the qualities of the plastics used, the expansion rate or density, the form or shape, the area, thickness, etc. Designing for shock absorption must take into account, in addition to these, the vector of shock, energy and other conditions applied to the container. Collection of such data relating to these basic aspects of shock absorbency by materials for that purpose is indispensable for planning shock absorbency of the package containing the product to be protected. It is necessary for the packaging industry to promote such activities by the cooperative work with user industries and public agencies.

(4) Measures for the environmental protection

In many of the industrial countries that comprise the export market for Singaporean products, arrangements are in effect for the collection and recycling of plastics. Further, in Singapore also the government is strengthening efforts of this kind. It is necessary for the industry to study this in reference to its plastic container sector.

4.5 Wooden Container Sector

4.5.1 Overview

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

Many of these companies, in addition to making wooden boxes, pallets and crates, are in the lumber business, and handle Malaysian lumber in particular, and are makers of plywood and building materials. They have formed the Singapore Timber Manufacturers' Association.

85% of their shipment is consumed domestically, and 50% of shipment is sent directly to users. In keeping with the increase in containerization, there has been a steady decline in demand for wooden crates and boxes for packaging. About 15% of production is pallets for export, mostly to Japan.

4.5.2 Production

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.

There is a standard for pallets (Singapore Standards, SS 334), adopted in 1988, and there are very few occasions when a user will call for something other than that. Such special-order users tend to be MNCs, that want to buy pallets that match the standard used within the company. These may be made so as to permit insertion by the forklift from two, three or four sides, or may be one-way pallets or returnable, or may have rounded corners and be needed in non-standard sizes. Pallet makers have taken orders for a total of 1,600 different pallets.

Because of the manner of use, there are requirements that the pallets be light in weight and not absorb moisture, and not be prone to attack by insects such as termites, and to be durable. It is difficult to do much regarding the first two conditions, but measures are taken regarding the third.

4.5.3 Market

The major use of wooden boxes is for packing goods for shipping and storage, and, prior to that, transport of finished and unfinished goods and materials in the factory, etc. Because of the advance of containerization, pallets are now mostly used for movement of goods within the plant.

4.5.4 Operation

According to the Industrial Census, the 16 wooden box makers employed 418 persons, for an average of 26 persons that is the lowest in the entire packaging materials industry.

The value of shipments per employee is low, at S$123,000, or 75% of the packaging materials industry average and 60% of the average for all manufacturing. Both value added and wages and salaries per worker are the lowest among the industry's sub-sectors, and as the nature of the work is not pleasant, it is difficult to hire people.

Lumber related companies including these 16 require relatively large areas for storage of logs and lumber (the average is about one hectare), and because of this and the high reliance on Malaysian lumber, these companies are concentrated near the source, in the Sungei Kudat industrial park near the border.

4.5.5 Issues

The major issues in this sector of the packaging materials industry are almost all related to pallets.

(1) Standardization of pallet specifications

For pallet users to require that their own specifications be followed in fabrication of pallets lowers productivity in pallet production, and tends to increase the production cost. Further, from the viewpoint of rationalization of distribution, it gives rise to inefficiencies in storage work through increasing storage space requirements. It is a general practice for such users to require pallets to have dimensions based on the dimensions of their products. But once special dimensions have been set, adjustments have to be made regarding work space, storage, equipment to be used in moving the pallets and so on, clearly imposing a disadvantage on business activities of the pallet maker. Unless standards can be imposed, pallet makers will not have this much less of an incentive to seek business.

Considering that standardization would contribute to rationalization of the distribution process, however, it is desirable that not only the pallet makers but also user industries and distributive sector companies cooperate in order to promote standardization.

(2) Reduction of moisture content of pallet

Moisture contained in pallets is a source of rusting of metal parts of products shipped and stored using those pallets. The moisture also increases weight and hence transport cost.

It is desirable that the pallet makers cure the wood in a kiln drier, but not only does this increase their costs it also increases the possibility that the wood will have cracking. It is necessary for the appropriate governmental agency to cooperate so that a standard that indicates optimum moisture content for pallets can be adopted and put into practice.

4.6 Glass Container Sector

Use of glass bottles for soft drinks, and other beverages, has been declining in Singapore, due to being replaced by metal cans, PET bottles and Tetrabrik or other paper containers. Production of glass bottles by the only company in the business was ended in the early 1980s and since then bottles have been imported from other Asian countries to the extent of S$30 million a year. Bottles with larger lots are imported from Malaysia and Thailand, and the smaller lots from Taiwan.

In keeping with recent efforts at recycling, glass bottles have been taken on a reviewing. In the case of Singapore, glass can not be recycled because there is no domestic glass industry, but there is a possibility that study of re-use of glass bottles with a high potential for general use will be rewarding.

4.7 Packaging Equipment Sector

There are no makers of packaging equipment in Singapore, and all equipment required is imported. The number of companies handling import business for packaging equipment, according to the PCS, is more than 40. They also provide technical services to their customers.

According to PCS, most of packaging operation in the manufacturing sector is done by hand and the productivity is half or a quarter of the processing operation. Thus, automation and rationalization of this area is an issue for the manufacturing as a whole, and it is thought that a high level of demand exists for packaging equipment. Demand would be particularly high for filling equipment for powders and liquids.

Further, in the future, it may be expected that demand for packaging equipment in adjacent countries will increase, and in such a case expansion to Singapore by the packaging machine manufacturers or activities such as installation of a show room or technical service center is Singapore will be increased.

4.8 Packaging Design Sector

Demands for packaging design which is acceptable to the over seas market, in keeping with the penetration of Singapore's commodities into the export market, international consultants to the area of package design as well as local designers in Singapore have been increased to provide packaging design services. At present, the enterprises involving in such services are relatively small in the business size.

Table 4-1 Number of Companies, Employees, Output and Value Added in Packaging Industry in Singapore (1990)

	(SSIC Code)	No. of Companies (A)	No. of Employees (B)	B/A	Output (C) (1,000S$)	C/A (1,000S$)	C/B (1,000S$)	Value Added (D) (1,000S$)	D/A (1,000S$)	D/B (1,000S$)	Value Added Ratio (D/C) (%)
Wooden boxes, packing case and crates except coffins	(33121)	16	418	26	51,416	3,214	123.0	15,421	964	36.9	30.0
Containers and boxes of paper and paperboard	(34120)	62	3,105	50	593,561	9,574	191.2	260,609	4,203	83.9	43.9
Plastic sheet, film and articles thereof	(35713)	59	1,967	33	289,155	4,901	147.0	83,404	1,414	42.4	28.8
Plastic bottles, boxes and containers (except for household use)	(35714)	27	1,227	45	122,664	4,543	100.0	49,861	1,847	40.6	40.6
Tinplate cans	(38151)	12	1,904	159	263,588	21,966	138.4	84,350	7,029	44.3	32.0
Metal cans, containers and related product nec	(38159)	11	571	52	171,745	15,613	300.8	35,053	3,187	61.4	20.4
Packaging Industry Total		187	9,182	49	1,492,129	7,979	162.5	528,698	2,827	57.6	35.4
Manufacturing Industry Total		3,716	352,067	95	71,578,471	19,262	203.3	21,694,304	5,838	61.6	30.3

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

Table 4-2 Sales (Domestic/Direct Export) of Packaging Industry in Singapore (1990)

(Unit: 1,000 S$)

	(SSIC Code)	Total Sales	Total Sales per Employee	Domestic				Direct Export		
				Total	Wholesales	Direct Consumtion	Retailers, Others	Total	ASEAN	Others
Wooden boxes, packing case and crates except coffins	(33121)	51,416 (100.0)	123.0	43,946 (85.5)	15,950 (31.0)	26,000 (50.6)	1,996 (3.9)	7,470 (14.5)	0 (0.0)	7,470 (14.5)
Containers and boxes of paper and paperboard	(34120)	590,428 (100.0)	190.2	370,846 (62.8)	127,087 (21.5)	229,444 (38.9)	14,315 (2.4)	219,582 (37.2)	122,063 (20.7)	97,519 (16.5)
Plastic sheet, film and articles thereof	(35713)	288,580 (100.0)	147.5	159,893 (55.4)	78,472 (27.2)	66,405 (23.0)	15,016 (5.2)	128,687 (44.6)	4,470 (1.5)	124,217 (43.1)
Plastic bottles, boxes and containers (except for household use)	(35714)	121,319 (100.0)	98.9	114,217 (94.1)	80,205 (66.1)	32,613 (26.9)	1,399 (1.1)	7,102 (5.9)	2,315 (1.9)	4,787 (4.0)
Tinplate cans	(38151)	264,897 (100.0)	139.1	219,912 (83.0)	128,366 (48.5)	91,446 (34.5)	100 (0.0)	44,985 (17.0)	14,401 (5.4)	30,584 (11.6)
Metal cnas, containers and related product nec	(38159)	171,751 (100.0)	360.8	164,863 (96.0)	7,778 (4.5)	150,023 (87.4)	7,062 (4.1)	6,888 (4.0)	5,306 (3.1)	1,582 (0.9)
Packaging Industry Total		1,468,391 (100.0)	162.1	1,073,677 (72.1)	437,858 (29.4)	595,931 (40.0)	39,688 (2.7)	414,714 (27.9)	148,555 (10.0)	266,159 (17.9)
Manufacturing Industry Total		71,893,626 (100.0)	264.2	24,793,686 (34.5)	9,146,234 (12.7)	11,506,043 (16.0)	4,141,409 (5.8)	47,099,940 (65.5)	7,033,757 (9.8)	40,066,203 (55.7)

Note: Figures in the parentheses show percent of "Total Sales".

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

Table 4-3 Leading User Industry Groups of Packaging Industry in Singapore (1990)

(Unit: S$)

	(SSIC Code)	Packing Material Cost (A)	% of Total (%)	Output (B)	A/B (%)
Food	(311/312)	214,230	20.2	2,044,108	10.5
Electronic Products & Components	(384)	202,086	19.1	27,878,127	0.7
Beverage	(313)	164,782	15.6	510,643	32.3
Petroleum Refineries & Petroleum Products	(353/354)	71,700	6.8	11,364,456	0.6
Paints, Pharmaceuticals & Other Chemical Products	(352)	68,692	6.5	1,771,876	3.9
Industrial Chemicals & Gases	(351)	47,252	4.5	3,149,982	1.5
Tabacco Products	(314)	47,607	4.2	287,643	15.5
Fabricated Metal except Machinery & Equipment	(381)	39,288		3,804,500	1.0
Wearing Apparel except Footwear	(322)	36,276		1,729,826	2.1
Electrical Machinery, Apparatus, Appliances & Supplies	(383)	31,608	3.0	2,433,948	1.3
Other Manugacturing Industries (Jewelry,Toys, etc.)	(390)	27,652		1,097,064	2.5
Plastic Products	(357)	26,234	2.5	1,428,576	1.8
Instrumentation Equipment, Photographic & Optical Goods	(386)	16,877		782,974	2.2
Machinery except Electrical & Electronic	(382)	10,152		3,380,666	0.3
Paper & Paper Products	(341)	9,236		816,267	1.1
Total Manufacturing		1,058,787	100.0	71,578,471	1.5

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

Table 4-4 Number of Packaging Manufacturers and Traders in Singapore *1

	Materials / Product Groups	Manufacturers	Traders
Glass		0	7
Metal	Tin Cans	13	10 + *2
	Drums & Pails	7	
	Composite Cans	1	
	Material Suppliers		20 +
	Machinery Suppliers		20 +
Paper	Manufacturer	2	
	Corrugated Board & Carton Manufacturer	18	
	Corrugated Box Converters	25	
	Solid Board Cartons (Printed)	50 +	
	Paper Bags	20	
	Paper Sacks	5	
	Fibre Drums	1	
	Tubes & Cores	2	
	Paper Cups	4	10
	Material Suppliers		40 +
	Machinery Suppliers		20 +
Plastics	Resin Manufacturer	3	
	Resin Suppliers		30 +
	Films & Bags	40 +	20 +
	Laminated Films (Multilayer Composites)	7	
	Blow Moulders (Rigid Bottles, etc.)	10 +	
	Injection Moulders (Rigid Boxes, Crates, etc.)	30 +	
	Pails & Drums	5	
	Foam Cushioning (EPS, PU, PE)	30 +	
	Vacuum Formed	10 +	
Total		283 +	177 +

Source: SMA "Singapore Packaging Industries Directory 1990"

Notes : *1 There is possibility of duplication in counting.

*2 "+" means more establishments than the figure.

Table 4-5 Composition and Use of Multi-layer Flexible Films in Packaging

Classification	Composition	Use
Food	OPP/CPP	Snacks
	PET/PE	Soups
	PVC/PE	Processed Meat
	NY(PET)/CPP	Retort Pouch
	PET/Al/CPP(HDPE)	Retort Pouch, Juice
Non-food	Cel/PE	Shampoo, Drugs
	NY/CPP	Liquid Medicine
	Paper/Al/PE	Compress

Notes: OPP: Oriented Polypropylene Film
PE: Polyethylene Film
PVC: Polyvinyl Chloride Film
Al: Aluminum Foil
HDPE: High Density Polyethylene Film
CPP: Cast Polypropylene Film
PET: PET Film
NY: Nylon Film
Cel: Cellophane

5 Packaging Technology Center Development Plan

On the basis of the current state and issues related to packaging in Singapore analyzed in previous chapters, this chapter recommends the development plan of a packaging technology center. Firstly, the chapter summarizes issues facing Singapore's packaging users, as well as the areas of improvement required for advanced and quality packaging (5.1). Then, the roles of the packaging center to play be devised to define in line with the development strategies to be formulated for the packaging sector[1] (5.2). The development of the packaging sector needs to be promoted as joint and coordinated efforts of related industries, institutions, and organizations, in which the packaging technology center will play a part of their role. Thus, the roles of the center will be defined after the roles of related industries, institutions, and organizations are defined within the framework of the sector development strategy. Based on these objectives, strategies, and roles defined, a development plan is recommended and evaluated in terms of economic and financial feasibility. Further, considerations and recommendations critical in successful implementation of the proposed plan are discussed (5.3).

5.1 Identifying Requirement for Improving Packaging

5.1.1 Characteristics of Packaging-user Industries and Issues Related to Packaging

Major user industries of packaging materials in Singapore are food and beverage, electronics/electrical, and chemicals and pharmaceuticals. These 3 industry groups account for 82.3% of total consumption by all the manufacturing industries, with each share being 40.0%, 22.1%, and 20.2% respectively.

5.1.1.1 Issues related to packaging in the electronics/electrical industry

Packaging in the electronics/electrical industry places importance in 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 package at storefront. As these

[1] In this report, all the industries which are commercially involved in packaging and allied services are collectively referred to as the packaging sector, including industrial package users (and their package-related divisions), the packaging industry, and the physical distribution industry.

characteristics are not likely to change in the future, transportation packaging will continue to form a major part of packaging for electronic/electrical products and parts.

Most of electronics/electrical enterprises in Singapore are operated by MNCs, which are now changing the positioning of Singapore electronics/electrical industry in their international business strategies. In particular, they are highly valuing Singapore for: 1) its strategic location in Asia, particularly ASEAN region, where further economic growth is expected, 2) its advantages as a distribution center supported by well-developed transportation and communication infrastructure and the availability of commercial services, and 3) its advantages as a production center originated from active promotion of foreign investment and highly educated human resources. At the same time, however, economic development of Singapore and industrialization of neighboring countries have changed Singapore's comparative advantage in industrial production. MNCs can no longer enjoy abundant and cheap labor force in Singapore. Previously, production of electronic and electrical products and parts in NIEs and developing countries have been mainly carried out in the form of assembly operation which combines key components imported from industrial countries with other parts and components locally produced. Now, MNCs are increasingly adopting a new strategy to limit production in industrial countries to products and parts which need to be retained for quick response to any changes in local 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 for the electronics and electrical industry. First of all, the packaging sector related to electronics and electrical products packaging must have the ability to make transportation packaging which provides sufficient protection for increasingly sophisticated and valuable products. Secondly, as production of new products will be increasingly carried out in Singapore, 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 outside the country, 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 with shorter time to market, and the distribution systems for products and parts are changing

accordingly to create 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.

Another recent trend having possible impacts on packaging for electronic/electrical products is that they are increasingly displayed in transportation packaging at storefront due to the changes in marketing techniques and distribution strategies of manufacturers. Thus, transportation packaging is increasingly required to have some functions which have been played by packaging.

Finally, 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.

5.1.1.2 Issues related to packaging in the 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 of products are low-cost commodities, so that it is economical to allow a certain degree of damage in transit, rather than to spend large 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 package at storefront, and consumers chose them based on information indicated on package.

The food industry in Singapore consists of 3 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 daily products, but they destine their products to markets of Malaysia, the Middle East, and Burnei, 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 foreign companies and local enterprises who supply general foods for international markets, including frozen foods and fishery products of export grade, chocolates and cakes, alcohol beverages and soft drinks. Local enterprises produce these products under OEM contract or license agreement with food companies in industrial countries.

The first subsector, specialized in the ethnic food market, has a huge potential market in China. However, most of them are SMEs, and they are often lagged 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 allow 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) demand size for packaging materials.

Markets served by the first and second sectors are characterized by strong price consciousness and acceptability for lower product quality. As a result, manufacturers tend to give priority to price over quality, and there are many cases of poor packaging, such as poorly sealed products which are not visible on appearance but adversely affect the ability to preserve food, and delamination caused by the use of improper packaging materials. Also, most of food companies in these categories have small production capacities and can not procure packaging materials and machinery that meet their own specifications. As a result, many of them have to obtain inappropriate materials or machinery which are available in the market. For instance, the frequent use of packaging materials with low gas-barrier or flare-barrier capability presents a problem in preservation of food; the canning is still used for products for which pouching and aseptic packaging are desirable; freeze-resistance grade materials are not used for frozen foods; labeling is used instead of printed cans which require a certain scale of production; and small production impedes the

automation of the packing process to cause a quality control problem. As a result, most of food companies in these sub-sectors have failed to establish competitive edges in quality against similar foods produced in other countries. If the situation continues, it is doubtful whether they will be able to maintain international competitiveness.

To keep their competitive edges, they should:

1) Re-evaluate their own products from international standards, learn about basic requirements for quality products, and improve food and packaging qualities on the basis of systematic food processing, quality control, and packaging techniques; and
2) Improve preservability of contents by package and increase shelf life, thereby to expand potential markets in terms of geographical distance.

Finally, food companies in the third subsector can generally obtain food processing, quality control, and packaging technologies from their parent companies or partners in corporate alliance, who also do packaging design. These companies 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.

5.1.1.3 Issues common to all the industries

In addition to the issues peculiar to the various industrial packaging users, as identified above, there are some other packaging requirements common to Singapore's industrial packaging users; namely 1) packaging which serves the purpose of streamlining the country's physical distribution system in order to make most use of Singapore's geographical advantages, and 2) packaging which addresses environmental problems, both domestic and international. These issues are discussed in more detail later.

5.1.2 Major Areas of Improvement in Packaging

5.1.2.1 General

This section summarizes major areas of improvement required for the packaging sector to develop the ability to upgrade packaging technologies and practices and to serve

as a supporting sector for industrial development of Singapore. They are divided into package-related issues facing various industries in Singapore, and those that are related to the need for further industrial development of the country and require committed efforts of the packaging sector as a whole.

Major issues facing the industries can be summarized as follows:

1) Products shipped from Singapore are damaged due to the lack of proper package design according to shipping and handling conditions. These 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 of 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 terminates 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 are produced due to insufficient production technology and quality control practices, such as irregular wave of corrugated paper.
5) Insufficient packaging due to improper packaging work is observed, particularly poor adhesion and etching in sealing of food package due to 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 advantages. As a result, the available contract packaging service is limited to simple packaging work on behalf of customers.

In addition, from the interest of developing the packaging sector, issues should not be limited to those which are exiting. Manufacturing industries in Singapore, the major users of packaging materials, are facing a domestic problem of increasing labor cost, with intensive competition from neighboring countries. To ensure sustainable growth, therefore, the industries need to differentiate themselves from other countries by fully capitalizing their own competitive advantages. In particular, the country handicapped by a small domestic market needs to make most of their advantages of 1) geographical advantages in Southeast Asia, 2) well-developed transport and communication infrastructure, 3)

government incentives to export industries for inducement of foreign investment, 4) a pool of engineers, which attracts regional production and distribution bases of foreign companies.

In this connection, the electronics/electrical industry is expected to promote 1) the transition to production of more sophisticated computer peripheral equipment, such as disk drives and printers, and 2) the strengthening of distribution functions to temporarily store components and parts from Singapore and neighboring countries and to ship them again on a just-in-time basis. Also, automotive parts and machinery industries are making similar moves to expand parts distribution bases.

The food industry, in addition to the function as the gateway of an import route to Malaysia, is increasingly responsible for 1) processing and packing of food materials of Southeast Asia for exports to global markets, and 2) repackaging of food products for exports to the Southeast market as the distribution and marketing center. 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 increasingly produces fine and speciality chemicals which require small-lot production with large varieties and technical service, and sell them to nearby countries. This is also an example of using comparative advantages over neighboring countries, marked by labor force of higher technology and efficient distribution service.

These industrial changes call for the packaging sector which can support these moves. To this end, it is expected to develop the following abilities related to packaging technology, in addition to the issues discussed already:

1) Packaging design ability suitable for transportation of more sensitive and valuable products
2) Ability to produce more precisely designed packaging materials
3) Ability to develop and produce packaging materials to meet increasingly diverse demand
4) Improvement of package design and printing technology
5) Ability to improve packaging for enhancing advantages in distribution

The above issues can be classified into the following three areas:

1) Packaging design
2) Packaging material manufacturing
3) Packaging operation

Further, the ability to develop packaging which meet environmental requirements from importing countries is bending demanded in response to the rise in international movement demanding environmental preservation.

5.1.2.2 Areas of improvement related to packaging design

Many of 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, while collecting 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[2] design ability because most of packaged goods are exported. Major tasks related to the improvement of packaging design technology are as follows.

(1) Transport environment study

The most conspicuous issue related to packaging design concerns with transportation packaging.

The issue is particularly observed in transportation of electronic and electrical products and components. The primary factor involved is found in the fact that local electronic and electrical manufacturers do not have their own packaging design ability and mainly adopt packaging design instructed by their parent companies or copied from available design. As a result, they fail to take into account environmental factors peculiar to Singapore.

In the case of food industry, they also experience frequent damages to packages for exports to the Middle East and other markets with severe shipping and handling conditions. However, given relatively cheap prices of products and the lack of package control ability in the food industry, damages have ended to borne by packaging material makers and food suppliers. No efforts have been made to improve packaging design.

To deal with these issues, technical data related to packaging design, including weather, handling, and transport conditions in export markets and Singapore, need to be collected at first. These data allow proper packaging design using suitable packaging technologies and tailored to product strength and characteristics of packaging materials.

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[2] Although export packaging basically serves the same purpose as industrial packaging (transportatoin packaging), it is different from others due to differences in physical impacts received, meteorological conditions exposed, and commercial practices in importing countries, as packaged goods are exported overseas, together with stricter demand for transport cost saving than domestic transport.

(2) Improvement of packaging for streamlining of distribution system

At present, pallets are used for storage and transportation of most of products, including electronic and electrical products. Nevertheless, pallets actually used vary greatly in construction and size among users. The standardization of pallet size brings about smooth handling and transportation, and interchangeability of pallets, leading to significant improvement in the physical distribution process. Although it is very difficult to change pallet sizes once adopted, companies are expected to start standardization efforts once they began to realize that such a change produce tangible benefits.

Corrugated carton is another important packaging material in the physical distribution system in Singapore. At present, 70% of international cargoes are handled by containers. At Singapore Port, container transport increased from 6.4 million units in 1990 to 7 million in 1991, and 10 million within a few years later. Proliferation of containers has eliminated the need for heavy packaging, so that corrugated carton has become most common. Accordingly, the efficiency in fitting corrugated carton to containers and the minimization of transport costs are becoming important factors in corrugated carton design, particular its size. While the size of maritime containers is unified on an international basis, that of containers for air cargo varies with the type of aircraft. It is therefore important to conduct a study to analyze the current state of container transport and to support the designing of proper corrugated carton size, as in the case of standardization of pallets.

(3) Improvement of packaging for cost optimization

The direct objective of cost optimization in transportation packaging is to provide the sufficient product protection effect by using minimum required packaging materials. Cost optimization can not be accomplished simply by minimizing the packaging materials cost. Reduction of the packaging cost may lead to a cost increase related to packaging operation, handling or transport, or a cost increase due to the increase in product damage. On the other hand, the reduction of the packaging cost may be more effectively achieved through modification of product strength, rather than that of packaging materials. Obviously, cost optimization in the packaging process involves overall efforts covering product design and manufacturing process. Now that manufacturing industries in Singapore can no longer rely their international competitiveness on cheap labor cost, comprehensive cost reduction efforts are becoming increasingly important. The packaging sector is expected to play a part of role in such efforts.

Further, correcting excess packaging caused by improper packaging design is an important area of improvement for the electronic and electrical products, although the need has not been clearly recognized by most of the manufacturers.

5.1.2.3 Areas of improvement related to packaging materials manufacturing

Improvement in packaging materials manufacturing is demanded not only from the electronic and electrical industry, but from the food industry and the chemical and pharmaceutical industry as well. In fact, 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

Most of above 370 enterprises of the electronic/electrical industry operating in Singapore are MNCs and expect local packaging materials suppliers to supply products conforming to their specifications at competitive prices. In particular, their primary demand lies in strict quality control. The electronic and electrical makers demand the packaging materials industry to perform strict total quality control from acceptance tests on raw materials to in-process and completion tests. At the same time, they demand proper maintenance of testing equipment. Some users even send their engineers to packaging materials makers for inspection of intermediate products and joint development of packaging materials. Nevertheless, only large suppliers are capable of meeting users' demand, and packaging materials which can not made by local suppliers in terms of specification and quality are imported. Obviously, the upgrading of the packaging sector as a whole requires small- and medium-size manufacturers to develop the ability to meet quality control requirements.

In contrast to the electronic and electrical industry, the food industry does not have strong voice to the packaging industry because enterprises in the industry are generally small in size. As a result, they mainly use standard packaging materials available in the market, under the assumption that these materials are the same as those which have been previously used or approved on the basis of samples. It is difficult for users to evaluate quality characteristics in terms of both equipment and technology. Table 5-1 shows quality control requirements and items for the food industry. In summary, quality control problems in the food industry often involve problems related to the quality of packaging materials and those related to packaging techniques, so that poor quality of packaging materials directly leads to defective products. Thus, the improvement of

quality control techniques of the packaging materials makers is critical to the success of the food industry.

In the chemical and pharmaceutical industry, particularly liquid type chemicals have been experiencing oxidization of contents due to defective containers (including pinholes in blow-molded plastic containers and poor cap sealing), indicating poor levels of plastic molding and quality control techniques.

(2) Enhancing marketing function played by packaging

In the future, there will be an increasing need for improvement of marketing function of packaging materials. This applies to foods which emphasize consumer packaging, as well as to packages for electronic and electrical products which have so far placed priority to transportation packaging.

Notably, electronic and electrical products are undergoing the upward transition of the product structure from components to end products. Also, these products are increasingly displayed in package at storefront due to the changes in marketing policies of manufacturers and dealers. As a result, their packages are required to be designed in consideration to the effect of store display on end users, while meeting shipping requirements. This requires package graphic design and printing techniques appealing to general consumers in the international market.

Food packages are facing similar demand with the change in distribution channels, particularly the increase in the number of supermarkets. Here, food packages need to be improved in many respects, in addition to the designing of beautiful packaging materials having the eye-catching effect, e.g., to prevent contents from moving or "jumping" in the package at a place of display including supermarkets, and to ensure visibility of important information including the instruction on use.

(3) Adjustment to diverse distribution and consumption patterns

Food distribution and consumption patterns are becoming increasingly diverse, including proliferation of vending machines, development of cold chains, and wide market acceptance of retort packed foods accompanying the increasing popularity of microwave ovens. In response, a variety of materials are used for food packaging. Unfortunately, however, food makers who use packaging materials are not in a position to obtain information on diverse materials.

This is particularly true in food manufacturers in Singapore, who serve a very small market and thus have to rely on standard packaging materials. The at-arms-length relationship with packaging materials makers forces food suppliers to obtain materials information by themselves, which is difficult for most of them, excepting beverage and

tobacco, who are small to medium size with less than 50 employees and spend around S$6,000 annually for R&D activity, according to the Census of Industry. Thus, packaging materials and machinery makers are expected to supply latest technical information to food manufacturers, but they do not have much R&D budget[3] and rely on raw materials suppliers (many of them are foreign companies) for limited information.

5.1.2.4 Areas of Improvement related to packaging work

(1) Dissemination of suitable packaging work technology

The issues related to packaging work are seen mostly in the food industry. The industry mainly consists of small companies and uses general-purpose packaging materials. As a result, they do not have close business relations with packaging materials and machinery makers, impeding the industry from obtaining appropriate technical information on packaging operation. This means, food manufacturers solve most of package-related problems by themselves. Again, the securing of experts for problem solving is difficult for the food industry dominated by small companies. The situation is clearly reflected in a variety of poor packaging, including the leakage through the mouth of edible oil and other liquid food containers and the sealing of metal cans, the delamination of film containers, the insufficient effect of extending product life by modified atmosphere packaging due to incomplete heat sealing, and moistening of contents.

The improvement of packaging techniques significantly affects packaging quality and productivity. Thus the development and commercialization of highly productive packaging technology and process are major concern for the food industry. And proper selection of the form of packaging and the shape of containers governs productivity in the packaging process. However, most of food companies are not capable of collecting information on these important items by themselves, as discussed earlier.

(2) Promoting mechanization of packaging process

In many industries, mechanization of the packaging process is lagged behind, compared to other processes. It brings not only cost benefits including the control of labor cost, but quality control benefits as well, such as uniform packaging.

Despite such benefits, mechanization is slow to be adopted in the packaging process in Singapore partly because manufacturing enterprises are relatively small and can still

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[3] According to the industrial census, the average metalwork product (including metal containers) manufacturer spends only S$645 for R&D annually, and the plastic product maker S$326, while the paper container industry consisting of 92 companies spends none on R&D.