13 clarifies more the relationships that the assembly parts much involves imported elementary parts.

Table 5.2-13 IMPORTED PARTS INVOLVED IN LOCAL PARTS

	No.	1	2	3	4	5	6	7
No.	Localy assembled parts / Imported elements	Tuner	Remote control	FBT	Switch	Volume contrc	Speaker	Relay
1	PCBs	○	○					
2	Chip parts	○	○					
3	Contacts	○	○	○	○	○	○	○
4	Molded bobbins	○	○	○	○	○		○
5	Semiconductor	○	○	○				
6	Capacitors	○	○	○				
7	Choke coils	○	○					
8	Resistors	○	○			○		
9	Cone paper						○	
10	Ferrite	○	○	○			○	○

5.2.7 Results of interview survey on primary suppliers

For the interview surveys, a total of 16 companies was selected from a variety of primary parts makers which directly supplied their products to set makers of electrical/electronic equipment. They include 4 companies wholly owned by foreign capital, 8 joint ventures, and 4 wholly owned by local capital. The Study Team then visited these suppliers for interview survey. Their opinions and views including future plans are described as follows. A summary of the interview is shown in ATTACHMENT 5-6.

(1) Capacity expansion and factory site

With rapid growth of demand for home appliances, communications equipment, and office machinery in recent years, these primary suppliers are willing to expand their production capacity. Out of 16 companies, 13 companies plan to enhance their production capacities, and 2 companies

have recently added their production facilities. Most of them plan to build new facilities within the existing sites, but some export-oriented companies consider to move from BOI's Zone I to Zone III.

(2) Export of components and parts

Twelve companies are exporting their components and parts and 7 companies exporting more than 50% of their products. Major export markets are North America and Australia for compressors for refrigerator use, Japan, NIEs, ASEAN countries, and China for compressors and evaporators for air-conditioner use. Thai CRT are exporting 5% of its CRTs to Indonesia. Toshiba Display Device (Thailand) are exporting all of its CRTs. These CRTs are also indirectly exported as parts of finished TVs mainly to EC and Japan. Their indirect exports to ASEAN from Thailand account for 5% of total. Electronic parts including condensers, transistors, and LSIs are supplied worldwide, including North America, EC, Japan, and NIEs.

(3) Procurement of parts

Out of 16 companies interviewed, 10 companies wanted to produce most of their parts internally, while 6 wanted to procure from local sources. In particular, manufacturers of CRTs, evaporators for refrigerators, and electronic parts, with high import content, tend to use local parts.

(4) Problems related to subcontractors

The largest number of suppliers cites quality as a major problem, followed by delivery time and price. Compared to set makers, complaints are more focused on quality and price. Production processes that are expected to develop in the country are presswork and electroplating, followed by casting, machining, metalworking, welding, plastic moulding, and rubber moulding, although responses vary greatly among suppliers to reflect diversity of products they produce.

(5) Economic scale of production

The standard production volume for major components to achieve economic feasibility is 1 million units annually for CRTs, 700,000 compressors for refrigerators, 300,000 compressors for air-conditioners, 600,000 evaporators for refrigerators, 600,000 plastic products (such as VTR cabinets and front covers), 24 million - 30 million press parts (e.g., metal pipes for air-conditioner evaporators), and 1.2 billion transistors and alkali electrolysis condensers.

(6) Advantages of Thailand in terms of investment opportunity

A majority of suppliers list, as advantages of Thailand for investment, BOI's incentives, low-cost labor force, and large domestic markets. In addition, Japanese-affiliated suppliers cited another advantage of Thailand that many Japanese set makers, buyers of parts, already existed in the country.

(7) Technical assistance

Out of 16, 3 suppliers are wholly owned by local capital, and one of them (producing metal press parts) receives regular technical assistance from a set maker. On the other hand, a majority of suppliers provide technical guidance for their own subcontractors. In addition, 30% of suppliers lend moulds dies and jigs to their subcontractors or furnish raw materials.

(8) Use of public technical institutions

Among various public technical support organizations, MIDI is used relatively frequently. However, some suppliers pointed out difficulty in learning practical skills due to the lack of long-term training programs.

(9) Request to the government and problems related to business activity

Nearly one half of suppliers want the government to improve technical education and training and to lower import duties. In particular, they cited

the need for upgrading vocational training at a diploma level, and long-term training programs at public technical institutions.

Reduction of import duties includes jigs and capital goods, in addition to raw materials and components and parts (electronic parts in particular).

As for major problems related to business operation, a majority of suppliers cited the shortage of engineers and middle management, the rise in wage, and the lack of the stability of the work force. Japanese-affiliated suppliers pointed out poor communication with workers of diploma or lower levels of school due to the low level of English language skills. On the other hand, local suppliers cited the shortage of fund for machinery purchasing.

ATTACHMENT 5-1 ELECTRICAL/ELECTRONIC ASSEMBLERS AND THEIR PRODUCTS (1/5)

	Assemblers	Estab.	Employee	Ownership (%)	Home Electrical Appliance						Audio-Visual				Telecom			OA Equipment								
					Air Conditioner	Refrigerator	Washing Machine	Microwave Oven	Electric Fan	Rice Cooker	TV	VTR	Radio	Audio	Telephone	Cordless Tel.	Facsimile	Computer	Printer	Key-Board	FDD	HDD	Monitor	Calculator	Copier	Others
1	A.P. National Co., Ltd.	1979	900	TH: 55 JP: 45	○	○	○			○																
2	Acme Industry	1989	260	TH: 51 JP: 49				○																		
3	Admiral Thailand	1971	n.a.	TH & USA	○	○																				
4	Ai-En (Thailand)	1987	60	TH & Taiwan														○								
5	Alcatel Thailand	1967	58	TH:100											○											
6	Asahi Electronics (Thailand)	1987	1,530	TH: 41 JP: 59									○	○												
7	Bangchong MITR	1979	130	TH:100							○	○	○													
8	Better Livings	1967	62	TH:100	○																					
9	Canon Hi-Tech (Thailand)	1990	780	JP:100															○						○	
10	Central Air Conditioning Industrial	1973	200	TH:100	○																					
11	Central Industrial Technology	1982	53	TH:100							○		○	○												
12	Chicony Electronics (Thailand)	1988	780	Taiwan:100																○						
13	Consolidated Electric	1976	125	TH & Singapore	○						○															
14	Daikin Airconditioning (Thailand) Ltd.	1987	270	TH: 60 JP: 40	○																					
15	Daikin Industries (Thailand) Ltd.	1990	750	JP:100	○																					

ATTACHMENT 5-1 ELECTRICAL/ELECTRONIC ASSEMBLERS AND THEIR PRODUCTS (2/5)

	Assemblers	Estab.	Employee	Ownership (%)	Home Electrical Appliance						Audio-Visual				Telecom			OA Equipment								
					Air Conditioner	Refrigerator	Washing Machine	Microwave Oven	Electric Fan	Rice Cooker	TV	VTR	Radio	Audio	Telephone	Cordless Tel.	Facsimile	Computer	Printer	Key-Board	FDD	HDD	Monitor	Calculator	Copier	Others
16	Elcom Research	1968	140	TH:100									○													
17	Elinthai	1977	150	TH & Netherland							○		○													
18	Federal Electric	1987	580	TH:100							○							○								
19	Fujitsu General (Thailand)	1991	180	JP:100	○																					
20	HEAT-X International	1978	28	TH:100	○																					○
21	Hitachi Consumer Products (Thailand)	1970	1,560	TH: 51 JP: 49		○	○		○		○															○
22	JVC Electronics (Thailand)	1991	n.a.	TH: 51 JP: 49							○															
23	JVC Manufacturing (Thailand)	1989	1,130	JP:100							○															
24	Kang Yong Electric	1964	1,230	TH: 63 JP: 37	○	○	○		○		○															
25	LINK-Carlyle	1985	140	TH & USA	○																					
26	Melco Consumer Products (Thailand)	1989	680	TH: 30 JP: 70	○																					
27	Melco Manufacturing (Thailand)	1987	990	TH: 2 JP: 98																	○					○
28	MHI - Maharajak	1988	430	TH: 49 JP: 51	○																					
29	Minebea Thai	1984	3,900	JP:100																○				○		
30	Muramoto Electron (Thailand)	1987	1,800	JP:100								○	○													

ATTACHMENT 5-1 ELECTRICAL/ELECTRONIC ASSEMBLERS AND THEIR PRODUCTS (3/5)

	Assemblers	Estab.	Employee	Ownership (%)	Home Electrical Appliance						Audio-Visual				Telecom			OA Equipment								
					Air Conditioner	Refrigerator	Washing Machine	Microwave Oven	Electric Fan	Rice Cooker	TV	VTR	Radio	Audio	Telephone	Cordless Tel.	Facsimile	Computer	Printer	Key-Board	FDD	HDD	Monitor	Calculator	Copier	Others
31	National Thai Co., Ltd.	1961	2,300	TH: 51 JP: 49					○		○		○	○												○
32	NAYA Electronics	1984	150	TH:100							○		○	○												
33	NEC Technologies (Thailand)	1988	610	JP:100											○	○										
34	Nitsuko Thailand	1988	310	JP:100											○	○										
35	P.T.S. Manufacturing	1983	200	TH & Taiwan		○	○				○		○													
36	Peacock Electric	1975	220	TH:100						○																
37	Philips Electrical	1962	540	TH & Netherland							○							○								
38	Sakata (Epson)	n.a.	n.a.	n.a.														○			○					
39	Samsung	n.a.	n.a.	TH & Korea							○	○														
40	Sanden Theco	1992	n.a.	TH: 51 JP: 33 Singr: 16	○																					
41	Sanyo Universal Electric	1959	5,220	TH: 70 JP: 30	○	○	○	○	○	○	○															
42	Sharp Appliances (Thailand)	1987	2,500	JP:100	○	○		○									○									
43	Sharp Thebnakorn Manufacturing	1992	430	JP:100							○															
44	Siam NEC	1981	290	TH: 49 JP: 51							○															
45	Singer Thailand Ltd.	1969	6,148	TH: 51 US: 48 OT: 1	○	○	○				○	○		○												

ATTACHMENT 5-1 ELECTRICAL/ELECTRONIC ASSEMBLERS AND THEIR PRODUCTS (4/5)

	Assemblers	Estab.	Employee	Ownership (%)	Home Electrical Appliance						Audio-Visual				Telecom			OA Equipment								
					Air Conditioner	Refrigerator	Washing Machine	Microwave Oven	Electric Fan	Rice Cooker	TV	VTR	Radio	Audio	Telephone	Cordless Tel.	Facsimile	Computer	Printer	Key-Board	FDD	HDD	Monitor	Calculator	Copier	Others
46	Sitthi Motor	1985	16	TH:100	○																					
47	Sony Siam Industries Company	1988	400	TH: 11 JP: 89							○		○	○												○
48	Star Telephone (Thailand)	1990	15	Taiwan:100											○											
49	Sum Puk	n.a.	162	TH: 60 HK: 40							○	○	○										○			
50	T.N. Metal Works	1984	90	TH:100					○																	
51	Takacom (Thailand)	1989	265	TH: 5 JP: 95											○	○										
52	Tanin Industrial	1962	1,000	TH:100							○		○	○												
53	Tatung (Thailand)	1990	130	Taiwan:100							○												○			
54	Tavon Computer	n.a.	200	TH: 100														○								
55	Tavon Electric	1981	150	TH:100									○	○												
56	Technology Applications (Thailand)	1986	1,490	TH: 41.6 SG: 54 UK: 4.4											○	○										
57	Thai Computer Manufacturing	n.a.	50	TH: 100														○								
58	Thai Telesystems Industry	1989	158	TH: 51 US: 45 Taiwan: 15											○											
59	Thai Electric Industry	1973	220	TH:100									○	○												
60	Thai Toshiba Electric Industry	1969	1,360	TH: 54 JP: 46		○	○			○	○															

ATTACHMENT 5-1 ELECTRICAL/ELECTRONIC ASSEMBLERS AND THEIR PRODUCTS (5/5)

	Assemblers	Estab.	Employee	Ownership (%)	Home Electrical Appliance						Audio-Visual				Telecom			OA Equipment								
					Air Conditioner	Refrigerator	Washing Machine	Microwave Oven	Electric Fan	Rice Cooker	TV	VTR	Radio	Audio	Telephone	Cordless Tel.	Facsimile	Computer	Printer	Key-Board	FDD	HDD	Monitor	Calculator	Copier	Others
61	Thai Uni Electric Industry	1986	130	TH:100									○	○												
62	Thai VASCO Electronic	1975	90	TH:100							○															
63	Thomson	n.a.	n.a.	n.a.							○															
64	Tokyo Try (Thailand)	1989	196	TH: 5 JP: 95														○			○					
65	Tomado	1991	170	Dutch:100														○								
66	Toshiba Consumer Products (Thailand)	1989	1,460	TH: 11 JP: 89	○	○																				
67	TRI-STAR Industy	1979	80	TH:100							○		○													
68	Uawithya Industry	1973	n.a.	TH:100	○																					
69	Union Zojirushi	1986	230	TH: 51 JP: 49																						○
70	World Electric (Thailand)	1988	500	JP:100							○	○						○								

Source: 1) LIST OF FOREIGN INVESTMENT '93, EIAJ: Electronic Industries Association of Japan

2) YOUR PARTNERS IN THAILAND, Federation of Thai Industry

3) DIRECTORY OF SUPPORTING INDUSTRIES IN THAILAND--1993, Business Information & Research Co., Ltd.

4) THAILAND INVESTMENT 1990, Cosmic Enterprises Co., Ltd.

ATTACHMENT 5-2 PRODUCT-WISE PRIMARY PARTS/COMPONENTS SUPPLIER (1/7)

A. KEY COMPONENTS	Estab.	Employee	Ownership	Products
TV COMPONENTS				
67 Muramoto Electron	1987	2,800	TH: 29 JP: 71	Press Parts for Magnetron, Shadow Mask & IMS for TV
139 Thai CRT	1986/89	13,770	TH: 70 JP: 30	CRT
REFRIGERATOR COMPONENTS				
54 Kulthorn Kirby	1982	920	TH:100	Compressor for Refrigerator
61 Matsushita Refrigeration	1989	300	JP:100	Evaporators/Thermostats
102 Sanyo Universal Electric	1959	4,644	TH: 51 JP: 49	Refrigerator/Compressors
149 Thai Refrigeration Components	1989	94	TH: 70 JP: 30	Evaporator for Refrigerator
AIR CONDITIONER				
23 Daikin Industries (Thailand)	1991	600	JP:100	Compressors for Air Conditioner
104 Siam Compressor Industry	1990	580	TH: 60 JP: 40	Compressors for Air Conditioner
137 Thai Compressor Mfg.	1988	490	TH: 60 JP: 40	Compressors for Air Conditioner
MICROWAVE OVEN				
155 Thai-Sanei	1987	140	JP:100	Metal Parts for microwave ovens/refrigerators
VTR				
146 Thai Mitsuwa	1988	380	TH: 55 JP: 45	Cabinet Front Assy for VTR
TELEPHONE				
5 Asian Stanley International	1989	451	TH: 17.5 JP: 72.5 US: 10	Light Emitting Diodes (LED)
B. ELECTRONIC PARTS				
RESISTOR				
135 Thai Asahi Denki	1989	260	TH: 5 JP: 78 TIW: 17	Resistor
CONDENSER/CAPACITOR				
21 Chinsan Electronic Industrial (Thailand)	1991	105	TH: 15 TIW:85	Capacitors (aluminum electrolytic)
40 Hana Microelectronics	1978	1,418	TH:100	Capasitors/Printed Board
68 Murata Electronics (Thailand)	1989	1,800	JP:100	Piezoelectric Buzzer, Ceramic Capacitor
72 NEC Technologies (Thailand)	1988	176	JP:100	Tantalum Chip Capacitor, Subminiature Relays
111 Siri Rung Roj Engineering	n.a.	n.a.	n.a.	Condenser
131 Tanin Condenser	1977	1,062	TH: 27 JP: 73	Condenser
TRANSFORMER				
55 KV Electronic Assembly	n.a.	n.a.	n.a.	Coil/Transformers
SPEAKER				
71 National Thai	1961	2,070	TH: 51 JP: 49	Speaker
120 Star Electronic	n.a.	n.a.	n.a.	Speaker
HEAD				
124 Summit Electronic Components	1988	300	TH:100	VHS head, FDD head

CONNECTOR/TERMINAL					
103	Showa International Trading (S.I.T.)	n.a.	n.a.	n.a.	Connector
134	Thai Arrow Products	1962/3	10,508	TH: 10 JP: 90	Terminal, Connector
174	Yoni Seri	n.a.	n.a.	n.a.	Terminal
SWITCH					
25	Delta Electronic (Thailand)	1988	1,480	TIW:100	Power Supply (switching)
69	Nakagawa East South Asia	1989	298	TH: 20 JP: 80	Switches
90	Printed Circuit Technology (Thailand)	1989	500	JP:100	Printed Circuit Boards, Switch, IC
167	Virasak Engineering	1985	25	TH:100	Switching Power Supply, Electronic Thermostat
RELAY					
72	NEC Technologies (Thailand)	1988	176	JP:100	Tantalum Chip Capacitor, Subminiature Relays
PRINTED CIRCUIT BOARD					
11	Bel Thai Industry	1988	33	TH: 75 BLG:25	Printed Circuit Board
26	Draco PCB	1990	227	TH:60.62 TIW:39.38	Printed Circuit Board
29	Elec & Eltek (Thailand)	1988	2,200	HK:100	Printed Circuit Boards
33	Fee (Thai)	1988	233	FRA:100	Printed Circuit Boards
40	Hana Microelectronics	1978	1,418	TH:100	Capasitors/Printed Board
56	Kyoto Electric Wire	1989	96	TH: 25 JP: 75	Power Cord(electric), Printed Circuit Boards
85	Pan Industrial Supply	1987	18	TH:100	Cable Harness (radio/audio), Printed Circuit Board Assembly
86	Panasonic Welding Industry (Thailand)	1991	55	TH: 51 JP: 49	Printed Circuit Board Assembly
90	Printed Circuit Technology (Thailand)	1989	500	JP:100	Printed Circuit Boards, Switch, IC
C. ELECTRONIC DEVICE					
TRANSISTOR					
93	Rohm Apollo Electronics	1988	750	JP:100	Transistor
IC					
90	Printed Circuit Technology (Thailand)	1989	500	JP:100	Printed Circuit Boards, Switch, IC
112	Sony Magnetic Products (Thailand)	1988	566	JP:100	Cassette tapes
122	Sum Hitechs	1989	80	TH: 19 JP: 81	IC, Metal Coating (chromium)

D. ELECTRICAL PARTS	Estab.	Employee	Ownership	Products
THERMOSTAT				
61 Matsushita Refrigeration	1989	300	JP:100	Evaporators/Thermostats
167 Virasak Engineering	1985	25	TH:100	Switching Power Supply, Electronic Thermostat
BUZZER				
68 Murata Electronics (Thailand)	1989	1,800	JP:100	Piezoelectric Buzzer, Ceramic Capacitor
COPPER PIPE/TUBE				
3 Amagasaki Pipe	1992	22	JP:100	Pipes (Copper)
8 Bangkok Metal Industry	1989	170	TH: 64 JP: 36	Copper Tubes
39 Furukawa Metal (Thailand)	1991	262	TH: 51 JP: 49	Copper Tube
59 Lib Seang Limited Partnership	n.a.	n.a.	n.a.	Varnish Tube
MAGNET				
32 FDK Tatung (Thailand)	1992	63	JP: 50 China:50	Ferrite Core
78 OTG Thai	1988	136	JP:100	Ferrite Core
92 Rehau	1972	118	GE:100	Gasket, Magnet
155 Thai-Sanei	1987	140	TH:100	Metal Parts for microwave ovens/refrigerators
WIRE HARNESS/CORD ASSY				
37 Fujikura (Thailand)	1985	2,800	JP:100	Cord Assy (Key board, Interface)
45 Johoku (Thailand)	1988	146	TH: 6 JP: 94	Wiring Harnesses
49 Kohnam Electric	n.a.	100	n.a.	Cord, Wireharness
85 Pan Industrial Supply	1987	18	TH:100	Cable Harness (radio/audio), Printed Circuit Board Assembly
154 Thai Wire & Cable Services	1988	797	TH: 10 JP: 90	Wiring Harnesses (electrical)
CORD/WIRE				
30 Far-Sights Electric	1989	210	TH: 70 n.a.: 30	Cord, Plug Cord
31 Farsight Development	n.a.	n.a.	n.a.	Wire
43 Hitachi Bangkok Cable	1982	230	TH: 62 JP: 38	Lead Wire
49 Kohnam Electric	n.a.	100	n.a.	Cord, Wireharness
56 Kyoto Electric Wire	1989	96	TH: 25 JP: 75	Power Cord(electric), Printed Circuit Boards
64 Molex (Thailand)	n.a.	n.a.	n.a.	Wire
97 S.C.H. Electric	n.a.	n.a.	n.a.	AC Cord
106 Siam Electric Industry	n.a.	n.a.	n.a.	Magnet Wire
110 Sino Thai Yong	n.a.	n.a.	n.a.	Mild Steel/Steel Wire
114 Sound & Light Industry	n.a.	n.a.	n.a.	AC Cord
123 Sumitomo Electric (Thailand)	n.a.	n.a.	n.a.	Magnet Wire
142 Thai Hitachi Enamel Wire	1980	350	TH: 69 JP: 24	Enamel Wire
147 Thai Multicore	1981	35	TH:100	Solder Bar/Wire

E. MOULD AND PRESS PARTS	Estab.	Employee	Ownership	Products
DIECAST PARTS/DIE				
9 Bangkok Metropolis Motor	1980	412	TH:100	Alminium Diecast
22 Choke Chai Lohakit	n.a.	n.a.	n.a.	Aluminium Diecast
24 Daisin Kogyo	1984	1,000	TH: 51 JP: 49	Aluminum Die-casting Parts
44 Intertools	1978	80	TH:100	Mould & Dies
161 Toyo Valve Thailand	1990	155	TH: 24 JP: 76	Brass Casting
PRESS PARTS/METAL PARTS				
16 Chai Yosh	n.a.	n.a.	n.a.	Press Parts
19 Chavin Metal Products	n.a.	n.a.	n.a.	Metal Parts
20 Cheval Electronic Enclosures	1980	250	TH: 18 US: 32 SGP:40	Press parts
41 Heng Charoen Metal	1973	250	TH:100	Fan Components
46 K.H. Metal Products	1991	250	TH:100	Press Parts
50 Kojo Part Standard	n.a.	n.a.	n.a.	Press Parts
51 Krathum Ban Casting	n.a.	n.a.	n.a.	Balancing Weight (Metal)
73 Nicom Jackol	n.a.	n.a.	n.a.	Spacer (Metal)
83 Paibul Printing	n.a.	n.a.	n.a.	Metal Name Plate/ Metal Panel Sheet
101 Sang Rung Ruang	n.a.	n.a.	n.a.	Metal Shaft
105 Siam Electric & Metal	n.a.	n.a.	n.a.	Press Parts
143 Thai Industrial Parts	1990	100	TH:100	Surface Treatment Painting/ Press parts
158 Thongchai Manufacturing	1988	36	TH:100	Press Parts for Electrical Appliance
171 Wireforms	1988	80	TH: 65 IND,SGP:35	Springs(precision)/ Press parts
PLASTIC PARTS				
1 A & P Polypack	1963	800	TH:100	Plastic parts
6 Bangbon Plastic Group	1987	216	TH:100	Plastic Parts
12 C.M. Industry	1980	343	TH:100	Plastic Injection Parts
13 Century Inoac	1988	103	TH: 51 JP: 49	Plastic Parts (electrical)
14 Century Plastic	1973	350	TH:100	Plastic Parts
15 Chai Mongkol	n.a.	n.a.	n.a.	Plastic Parts
35 Focus Plastic	n.a.	n.a.	n.a.	Plastic Parts
52 Krungtep Union Mfg.	1979	340	TH: 75 JP: 25	Plastic Parts
57 Lacasa	n.a.	n.a.	n.a.	Speaker Box

88	Phien Charoen	n.a.	n.a.	n.a.	Plastic Parts
89	Posa Plastic	n.a.	n.a.	n.a.	Injection Wage
98	Saha Charoen Metal Plastic	n.a.	n.a.	n.a.	Injection Wage
100	Saha Union	1979	n.a.	n.a.	Plastic Parts
115	Srithai Superware	1963	3,000	TH:100	Injection Wage/Plastic Parts
117	Sritong	n.a.	n.a.	n.a.	Plastic Parts
125	Sunny Precision (Thailand)	1989	65	TH: 20 JP: 80	Plastic Pars (electronic)
126	Super Fine Works	n.a.	n.a.	n.a.	Plastic Parts
127	Surapim	n.a.	n.a.	n.a.	Display Box
129	T. Krungthai Industry	1965	350	TH:100	Plastic Parts
130	Takahashi Plastics	1988	300	TH: 66 JP: 34	Plastic Injection Parts
145	Thai Kodama	1988	87	TH: 52 JP: 48	Plastic Parts
152	Thai United Plastic Industry	n.a.	n.a.	n.a.	Injection Wage
153	Thai Varodom	n.a.	n.a.	n.a.	Injection Wage
156	Thep Chai	n.a.	n.a.	n.a.	Plastic Parts
162	Union Nifco	1988	27	TH: 52 JP: 48	Plastic
163	Union Plastic	1969	120	TH:100	Plastic Parts
175	3K Plastic	n.a.	n.a.	n.a.	Plastic Parts
RUBBER PARTS					
2	A.C. Rubber	n.a.	n.a.	n.a.	Rubber
66	MSC PR Two Limited	n.a.	n.a.	n.a.	Rubber
F. SURFACE TREATMENT					
SURFACE TREATMENT					
76	Nissei Trading (Thailand)	1983	43	TH: 51 LAOS:25 JP: 24	Plastic Dip Moulding/Coating
79	P & Son Industry	1970	147	TH: 99 TIW: 1	Surface Treatment Painting
122	Sum Hitechs	1989	80	TH: 19 JP: 81	IC, Metal Coating (chromium)
140	Thai Electroplating	n.a.	n.a.	n.a.	Surface Treatment Painting
143	Thai Industrial Parts	1990	100	TH:100	Surface Treatment Painting/ Press parts

G. MATERIAL	Estab.	Employee	Ownership	Products
METAL MATERIAL (SHEET, PLATE)				
7 Bangkok Coil Center	1989	60	TH: 49 JP: 51	Cut Sheets/Slit Coils
74 Nikkei Siam Aluminium	1969	395	TH: 22 JP: 75	Aluminium
82 Paibul Packaging	n.a.	n.a.	n.a.	Metal Panel Sheet
94 S & T Enterprise	n.a.	n.a.	n.a.	Metal Materials
108 Siam Steel Service Center	1985	705	TH: 51 JP: 49	Steel
109 Siam Tinplate	1992	246	TH: 60 JP: 40	Tin Plate
110 Sino Thai Yong	n.a.	n.a.	n.a.	Mild Steel/Steel Wire
118 Sritong Electro Chemical	n.a.	n.a.	n.a.	Aluminum Plate
119 Sritong Electrochemical	n.a.	n.a.	n.a.	Alminum Plate
150 Thai Steel Service Center	1981	250	TH: 51 JP: 49	Steel Sheet
151 Thai Tinplate Mfg.	1958	634	TH: 60 JP: 40	Tin Plate
169 Watana Inter Trade	n.a.	55	n.a.	Aluminium
PLASTIC MATERIAL				
62 Mitsui Toatsu Chemical	n.a.	7	n.a.	Premix, Refnate
65 Monsanto Chemicals Thailand	1987	40	TH: 26 US: 74	Resin
116 Srithepthai	n.a.	n.a.	n.a.	Resin
148 Thai Polyglass & Chemical	1985	20	TH:100	Plastic Sheet
165 Universal Trading	n.a.	n.a.	n.a.	Resin
173 World Pigment Chemical	1973	250	TH:100	Plastic Compound
PAINT/PIGMENT/COLOR				
17 Chaiyaboon Brothers	n.a.	n.a.	n.a.	Solvent
27 Dry Color Hoechst	1976	246	GE:100	Pigment
28 Eason Paint Products	1985	60	TH:100	Surface Treatment Paint
42 Hexa Color (Thailand)	1989	70	TH: 51 JP: 49	Pigment
75 Nippon Paint (Thailand)	1968	505	TH: 60 JP: 40	Surface Treatment Paint
144 Thai Kansai Paint	1970	200	TH: 60 JP: 40	Paints & Thinner
166 V. Brother Industry	n.a.	n.a.	n.a.	Surface Treatment Thinner & Paint
170 Winson Screen	n.a.	n.a.	n.a.	Color for silk screen

ATTACHMENT 5-2 PRODUCT-WISE PRIMARY PARTS/COMPONENTS SUPPLIER (7/7)

PACKAGING MATERIAL					
4	Asian Packing Service (Thailand)	n.a.	n.a.	n.a.	Packing Box
34	Ferko Industrial	1964	150	TH:100	Styrofoam (packaging), Insulator Materials
48	K.L. Container	n.a.	n.a.	n.a.	Packing Box
60	Maporn Plastic	n.a.	n.a.	n.a.	Plastic Bag
70	Nan Dee Intertrade	n.a.	n.a.	n.a.	Stapler
80	P.P. Complex	n.a.	n.a.	n.a.	Stapler
82	Paibul Packaging	n.a.	n.a.	n.a.	Metal Panel Sheet
91	Raymond (Thai) Membrane Switches	n.a.	n.a.	n.a.	Sticker
95	S. Saha Tara Thailand	n.a.	n.a.	n.a.	Sticker
96	S. Sguan Patana	n.a.	n.a.	n.a.	Tape
99	Saha Tara (Thailand)	1977	165	TH:100	Self-Adhesive Tape, Stickers
106	Siam Electric Industry	n.a.	n.a.	n.a.	Magnet Wire
121	Sui Hua	n.a.	n.a.	n.a.	Wooden Case
133	Techno Foam	n.a.	n.a.	n.a.	Foam Packing
138	Thai Container Industry	n.a.	n.a.	n.a.	Packing Box
141	Thai Foam	1963	180	TH:100	EPS Foam Packaging, EPS Foam Sheet
157	Thong Samut	n.a.	n.a.	n.a.	Plastic Shrink Film
159	Toho Foam (Thailand)	1989	135	TH: 62.5 JP: 18.75 SGP:18.75	Foam (EPS for packaging)
164	Unique Plastic	n.a.	n.a.	n.a.	Plastic Bag
168	Watana Bhand Panich R.O.P. (Packaging)	n.a.	n.a.	n.a.	Stapler
OTHER MATERIAL					
10	Bangkok Pacific Steel	1981	150	TH:100	Silicon Sheet
47	K.I. Enterprise	n.a.	n.a.	n.a.	Felt

ATTACHMENT 5-3

Application Table for Electronic Parts By Finished Goods

No	Products	Parts Name / Application	Steel Cabinets	Plastic Cabinets	Glass Panels	Plastic Panels	Electronics Panels	Chassis	CRT	LCD(Monochrome, Color)	LED	Single side/Double side PCB	Mullet Layer PCB	Flexible PCB	BS Tuner	TV Tuner	FM Tuner	AM Tuner	Induction Mortar	DC Mortar	DD Mortar	Miniature Mortar	Fun Mortar	Miniature Speaker	Telephone Speaker	Audio Speaker	Mike	Magnetic Heads for F/D,H/D	Magnetic Heads for VTR	Power Cable Connector	Signal Cable Connector	Large Current Cable Connector	High Voltage Cable Connector	Key Board Switch	Touch Panel Switch	Bottom Switch	Remote Control Switch	Power Switch	Elementary Parts 1/	Semiconductor Device	Sensor	DC Units	Magnetron	Sheath Heater	Antenna	Filter
		No	1	2	3	4	5	6	7	8	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	38	39	40	41
		Key Components	Body & Casing						Display Parts			PCB			Tuner				Mortor					Speaker, Mike				Head		Wire Harness				Switches							Electronic Parts			Others				
1	AV Goods	Color TV		○	○			○	○		○	○	○	○	○	○										○				○	○		○		○		○	○	○	○		○			○	○
2		Monitor Display		○	○	○		○	○	○	○		○	○																○	○		○					○	○		○				○
3		Video Tape Recorder	○	○		○		○		○	○	○	○	○	○	○				○				○			○		○	○	○	○					○	○	○	○		○			○	○
4		Video Movie		○		○		○		○	○	○	○																○	○	○	○					○	○	○	○		○				
5		Stereo set	○	○		○		○		○	○	○	○				○	○			○	○				○	○			○	○	○					○	○	○	○		○			○	○
6		CD Player	○	○		○		○		○	○	○	○								○	○					○			○	○	○					○	○	○	○		○				
7		Car Stereo	○	○		○		○		○	○	○	○				○	○			○						○			○	○	○					○	○	○	○		○			○	
8	White	Microwave Oven	○			○				○	○	○									○		○	○						○	○	○	○		○			○	○		○		○				
9		Refrigerator	○								○	○							○				○							○	○							○	○		○						
10		Rice Cooker	○				○			○	○	○												○						○	○	○			○			○	○		○			○			
11		Washing Machine	○				○				○	○							○					○						○	○				○			○	○		○						
12		Air Conditioner	○	○			○			○	○	○							○					○						○	○	○			○			○	○		○						○
13	OA Goods	Portable Telephone		○			○			○	○	○	○	○										○	○					○	○				○			○	○		○			○		○	○
14		Cordless Telephone		○			○			○	○	○	○	○											○		○			○	○				○			○	○		○			○		○	○
15		Facsimile		○			○	○		○	○	○	○	○									○	○						○	○				○			○	○		○			○		○	○
16		Plain Paper Copier		○			○	○		○	○	○	○	○									○	○						○	○		○		○			○	○		○			○		○	○
17		Personal Computer		○		○		○		○	○	○	○	○									○	○					○	○	○				○			○	○		○			○		○	○
18		Word Processor	○	○			○	○	○	○	○	○	○	○						○				○	○			○		○	○				○			○	○		○			○		○	○
19		Laser Beam Printer		○			○	○		○	○	○	○	○						○			○	○						○	○		○		○			○	○		○			○		○	○
20		Dot Printer		○			○	○		○	○	○	○	○						○			○	○						○	○				○			○	○		○			○			○

(Note) 1/ Details of elementary parts under electronic parts are given in ATTACHMENT 5-4
(Source) JICA Team compiled.

ATTACHMENT 5-4

Application Table for Elementary Electronic Parts By Finishd Goods

No	Products	Parts Item / Parts Name / Application	1 Large Aluminum Electrolytic Capacitors	2 Small Aluminum Electrolytic Capacitors	3 Chip Aluminum Electrolytic Capacitors	4 Resin Mauled Tantalum Electrolytic Capacitors	5 Resin Dipped Tantalum Electrolytic Capacitors	6 Chipe Tantalum Electrolytic Capacitors	7 Electric Double Layer Capacitors	8 Disc Type Ceramic Capacitors	9 Cylindrical Axial Lead Type Ceramic Capacitors	10 Chip Type Ceramic Capacitors	11 Capacitor Networks	12 Ceramic Trimmer Capacitors	13 Thick Filem Chip Resistors	14 Fixed Carbon Filem Resistors	15 Fixed Metal Oxide Filem Resistors	16 Fixed Metal Filem Resistors	17 Hot-Molded Fixed Carbon Composition Resistors	18 Fixed Wirewound Resistors	19 Fuse Type Metal Oxide Film Resistors	20 Thick Filum Resistor Networks	21 Thermistors	22 Rotary Potentiometers	23 Slide Potentiometers	24 Trimmer Potentiometers	25 Variable Inductors	26 Fixed Inductors	27 Inductors	28 Peaking Inductors	29 EMI Filters	30 SAW Filters	31 LC Filters	32 Line Filters	33 Noise Filters	34 Ceramic Filters	35 Transistors	36 Diodes	37 IC	38 LSI	39 LCD	40 LED	41 Thermos Sensors	42 Humidity Sensors	43 Photo Sensors	44 Fuze
1	AV Goods	Color TV	○	○	○					○		○		○	○	○	○	○					○			○	○			○	○		○			○	○	○	○	○	○				○
2		Monitor Display	○	○	○					○		○				○	○	○	○				○			○			○	○				○	○		○	○	○	○	○				
3		Video Tape Recorder	○	○	○	○			○	○	○		○		○	○	○	○	○		○	○		○	○	○	○		○	○	○	○		○	○	○	○	○	○	○	○	○			○	
4		Video Movie	○	○						○					○			○					○			○											○	○	○	○	○			○	
5		Stereo set	○	○				○	○	○	○	○		○	○	○	○	○		○	○	○	○	○	○	○	○	○	○		○	○	○					○	○	○	○	○			○	
6		CD Player		○	○	○	○	○	○	○		○		○	○	○	○	○						○	○		○			○					○	○	○	○	○	○	○			○	
7		Car Stereo		○		○	○			○	○			○	○	○		○					○	○		○	○	○	○	○							○	○	○	○	○			○	
8	White Goods	Microwave Oven		○		○	○			○		○			○	○	○	○	○	○	○			○		○	○	○			○	○			○			○	○	○	○	○	○				
9		Refrigerator		○		○	○	○		○		○			○	○	○	○	○		○			○	○					○	○							○	○	○	○	○	○				
10		Rice Cooker		○		○	○	○		○		○			○	○	○	○	○		○			○						○	○							○	○	○	○	○	○				
11		Washing Machine		○		○	○	○		○		○			○	○	○	○	○		○									○	○							○	○	○	○	○	○				
12		Air Conditioner	○	○				○				○			○	○	○	○	○	○	○		○	○					○		○					○			○	○	○	○	○	○	○	○	○	
13	OA Goods	Portable Telephone			○			○				○		○	○			○									○	○	○	○	○	○	○				○	○	○	○	○	○				
14		Cordless Telephone		○				○		○		○		○	○	○	○	○									○	○	○	○	○	○			○		○	○	○	○	○	○				
15		Facsimile	○	○						○					○	○	○	○	○		○		○	○						○	○				○	○		○	○	○	○	○	○	○		○	
16		Plain Paper Copier		○						○					○	○	○	○	○				○	○					○	○	○	○			○	○			○	○	○	○	○	○	○	○	○	
17		Personal Computer	○	○	○	○	○	○		○		○			○	○	○	○	○		○		○	○							○	○			○	○			○	○	○	○	○	○	○		○	
18		Word Processor	○	○		○	○		○	○		○			○	○	○	○	○		○		○	○						○			○					○	○	○	○	○	○	○			
19		Laser Beam Printer	○	○		○	○			○		○			○	○	○	○					○	○						○					○	○			○	○	○	○	○	○	○	○	○	
20		Dod Printer		○	○					○					○								○												○	○			○	○	○	○	○	○				

(Source) JICA Team compiled.

ATTACHMENT 5-5 SUMMARY OF QUESTIONNAIRE SURVEY TO 12 ELECTRICAL/ELECTRONIC ASSEMBLES (1/4)

A. Investment and Market

A1. Expansion plan of assembly factories

1)	Yes	= 11
2)	No plan	= 1
		12

A2. Factory site for the expansion

1)	Existing factory site	= 6 (BOI Zone I=2, Zone II=4)
2)	BOI Zone III area	= 1
3)	Under consideration	= 4
		11

A3. Superiority of Thailand in doing business (Plural answers)

1)	Competitive manpower	= 10
2)	Domestic market size	= 9
1)	BOI incentives	= 4
4)	Geographical advantage	= 3
5)	Availability of materials	= 2
5)	Others	= 6
		34

B. Local Procurement

B1. Local procurement policy

1)	To increase	= 5
2)	Not to increase	= 7
		12

ATTACHMENT 5-5 SUMMARY OF QUESTIONNAIRE SURVEY TO 12 ELECTRICAL/ELECTRONIC ASSEMBLES (2/4)

B2. Prior subsectors to be promoted in Thailand (Plural answers)

1)	Electro plating	= 5	6)	Plastic	= 2
2)	Foundry	= 3	7)	Casting	= 1
3)	Forging	= 3	8)	Heat treatment	= 1
4)	Machining	= 3	9)	Welding	= 1
5)	Rubber	= 3	10)	Assembling	= 1
				Total	= 23

B3. Problems in local procurement (Plural answers)

1)	Low quality	= 10
2)	Unstable delivery	= 8
3)	Lack of technology/capability	= 5
4)	Communication gaps	= 2
		25

B4. Request for overseas suppliers to invest in Thailand

		Yes	No
1)	Past experience	3	8
2)	Possibility in future	5	6

C. Linkage with Primary Suppliers

C1. Interest in developing exclusive and long-term subcontracting systems with suppliers

1)	Interested	= 3
2)	Interested but impossible in Thailand	= 2
3)	Not interest	= 6
		11

ATTACHMENT 5-5 SUMMARY OF QUESTIONNAIRE SURVEY TO 12 ELECTRICAL/ELECTRONIC ASSEMBLES (3/4)

C2. Do you have a supporting organization for local suppliers?

1)	Yes, we do	= 2
2)	No, we don't, but want to	= 3
3)	No, we don't	= 7
		12

C3. Assistance having been so far given to suppliers

1)	Technical assistance	= 9
2)	Supply to mould & die	= 9
3)	Supply to materials	= 7
4)	Training in Thailand	= 3
5)	Capital investment	= 2
6)	Managerial assistance	= 1
7)	Dispatch of management staff	= 1
8)	Training in Japan	= 1
		33

D. Possibility of Collaboration or Co-work with Competitors in Doing Business

D1. For attracting a common supplier from overseas to Thailand

1)	We have collaborated and/or will do	= 2
2)	We did not and will not do.	= 10
		12

D2. For standardizing parts/components for common use

1)	Basically impossible in collaboration with competitors.	= 13
2)	Suppliers will standardize them by themselves as necessity.	= 4
		17

ATTACHMENT 5-5 SUMMARY OF QUESTIONNAIRE SURVEY TO 12 ELECTRICAL/ELECTRONIC ASSEMBLES (4/4)

D3. For technology transfer programs

1)	Ready to consider depending upon a detailed scheme of the program.	= 6
2)	Ready to collaborate if any direct benefits to our company are expected.	= 3
3)	Collaboration is not necessary since we have our own programs.	= 2
3)	Difficult to collaborate with competitors.	= 1
		12

E. Globalization and other General Questions

E1. Countermeasure to implementation of AFTA

1)	Considering	= 9
2)	No concrete idea yet	= 3

E2. Request to the Thai government

1)	Lowering of import duties on parts and materials	= 6
2)	Simplification of import/export procedures	= 5
3)	Lack of technology education	= 4
4)	Encouragement of foreign investment	= 3
5)	Improvement of traffic congestion	= 2
6)	Development of electronic parts industry	= 1
7)	Collection & compilation of statistical data on supporting industry	= 1

ATTACHMENT 5-6 SUMMARY OF QUESTIONNAIRE SURVEY TO 16 ELECTRICAL/ELECTRONIC COMPONENTS/PARTS SUPPLIERS (1/4)

A. Investment and Location

A1. Expansion plan of factories

1)	Yes	= 13
2)	No plan	= 3
		16

A2. Factory site for the expansion

1)	Existing factory site	= 9 (BOI Zone I=3, Zone II=5, Zone III=1)
2)	BOI Zone I area	= 2
3)	BOI Zone III area	= 2
		13

A3. Superiority of Thailand in doing business (Plural answers)

1)	BOI incentives	= 10
2)	Competitive manpower	= 9
3)	Domestic market size	= 7
4)	Geographical advantage	= 3
5)	Infrastructures	= 3
5)	Others	= 4
		36

B. Local Procurement

B1. Local procurement policy

1)	To increase	= 6
2)	Not increase	= 10
		16

ATTACHMENT 5-6 SUMMARY OF QUESTIONNAIRE SURVEY TO 16 ELECTRICAL/ELECTRONIC COMPONENTS/PARTS SUPPLIERS (2/4)

B2. Prior subsectors to be promoted in Thailand (Plural answers)

1)	Foundry	= 3	5)	Welding	= 2
2)	Electro plating	= 3	6)	Casting	= 1
3)	Machinery	= 2	7)	Heat treatment	= 1
4)	Plastic moulding	= 2	8)	Rubber moulding	= 1
				Total	= 15

B3. Problems in local procurement (Plural answers)

1)	Low quality	= 6
2)	High price	= 3
3)	Unstable delivery	= 2
		11

B4. Request to invest in Thailand from an assembler/assemblers

1)	Requested	= 0
2)	Not requested, though discussed with them	= 1
3)	Neither requested, nor discussed	= 8
		9

C. Linkage with Parts Suppliers

C1. Interest in developing exclusive and long-term subcontracting systems with suppliers

1)	Interested	= 4
2)	Interested but impossible in Thailand	= 3
3)	No interest	= 4
		10

ATTACHMENT 5-6 SUMMARY OF QUESTIONNAIRE SURVEY TO 16 ELECTRICAL/ELECTRONIC COMPONENTS/PARTS SUPPLIERS (3/4)

C2. Assistance having been so far given to sub-sectors

1)	Technical assistance	= 9
2)	Supply of mould & dies	= 6
3)	Supply of materials	= 4
4)	Training in Thailand	= 3
5)	Capital investment	= 1
6)	Managerial assistance	= 1
		24

D. Possibility of Collaboration or Co-work with Competitors in Doing Business

D1. For securing an economic production scale in cooperation with competing parts manufactures

1)	Has already tried	= 2
2)	Has not tried yet, but will try in the near future	= 3
2)	Has not tried yet, and will try not in the near future too	= 5
		7

D2. For technology transfer programs

1)	Ready to consider depending upon a detailed scheme of the program.	= 8
2)	Ready to collaborate if any direct benefits to our company are expected.	= 1
3)	Difficult to collaborate with competitors.	= 1
		10

ATTACHMENT 5-6 SUMMARY OF QUESTIONNAIRE SURVEY TO 16 ELECTRICAL/ELECTRONIC COMPONENTS/PARTS SUPPLIERS (4/4)

E. Globalization and other General Questions

E1. Countermeasures to implementation of AFTA

1)	Considering	= 6
2)	No concrete idea yet	= 4

E2. Request to the Thai government

1)	Lack of technology education	= 7
2)	Lowering of import duties on parts, materials and production facilities	= 6
3)	Simplification of import/export procedures	= 1
4)	Improvement of social infrastructures	= 1
5)	Long-term technical assistance programs	= 1
		16

Source:JICA team questionnaire & interview survey

Chapter 6 Diagnoses of Production and Management Technologies in Thai Supporting Industries

6.1 Method of Technology Diagnosis

6.1.1 Diagnosis by visiting companies

The Study Team selected companies in autoparts and electrical/electronic parts industries from several directories of Thai supporting industries, and classified them by production process. A technical expert on each process visited the selected companies employing the process to inspect their plants and made surveys by interviewing persons responsible for these plants. Each technical expert diagnosed the technology level of each company by using a 5-grade rating system according to the technology diagnosis manual prepared by process or industry (refered to as "process" hereinafter).

All technical experts visited and diagnosed 56 companies, as indicated in the table below. Four technical experts participated in the technology diagnosis project.

Process	Number of companies visited
Ferrous foundry	11
Presswork	14
Plastic moulding	12
Rubber moulding	6
Al alloy die-casting	8
Die-forging	5
Total	56

6.1.2 Technology level rating procedure in supporting industries

Basic policy on rating technology level of Thai supporting industries is to make a quantitative analysis of data obtained from the selected companies and diagnose them by a 5-grade rating. The rating procedure as shown in Figure 6.1-1 will be concretely described hereinafter.

(1) Setting technology level rating items

The Team classified technologies roughly into 2 categories: "production technology" and "quality control and assurance technology". Each of the 2 categories was divided into "hardware" and "software". Thus, a matrix of 4 rating sub-categories was constructed. The 4 rating sub-categories are common to all processes.

	A. Production	B. Quality Control & Assurance
1. Hardware	A-1. Production facilities	B-1. Equipment for quality control/assurance
2. Software	A-2. production technology	B-2. Quality control/assurance system and its operation

Each of the 4 rating sub-categories, A-1, A-2, B-1 and B-2, was broken down into 5 to 8 sub-items, specific to each process, because there are different rating sub-items between industries, for example, between die-casting and presswork industries.

(2) Rating criteria

The Team adopted 5 rating criteria so that there would be no personal difference in the results of rating between the 4 technical experts who diagnosed the selected companies' technology levels. Table 6.1-1 gives the scores corresponding to the 5 rating criteria for sub-items, of which the highest score (5 marks) corresponds to the average technology level in industrialized countries with the lowest score (1 mark) corresponding to a cottage industry level. It should be noted that these scores are given to individual rating sub-items, but not show the total technology levels of plants. For example, a plant may make the highest score (5 marks) in a sub-item concerning machinery & equipment and the lowest score (1 mark) in that of quality control system.

Table 6.1-1 5-GRADE RATING CRITERIA FOR SUB-ITEMS

Score (marks)	Rating Criteria for Technology Elements (sub-items)	International Comparison
5	Equipment and technology are appropriate from the viewpoint of the required quality for products produced by a plant.	Average level of OEM parts industries in industrialized countries.
4	Almost appropriate equipment and technology are used, though they must be improved.	Top level in ASEAN parts industries except companies with foreign capital
3	Unappropriate equipment and technology, deficient in parts, are used at a considerably high rate.	Average level in ASEAN parts industries except companies with foreign capital
2	Unappropriate equipment and technology are used to cause a low quality of product.	Lower level in ASEAN parts industries except companies with foreign capital
1	Obsolete and premodern equipment and technology are used.	The lowest level in ASEAN parts industries except companies with foreign capital

(3) Visiting and diagnosing companies

A technical expert on each process (such as foundry or press work expert) visited companies, inspected their plants, and interviewed the persons responsible for the plants. Then he rated technology levels of the plants by sub-item by referring to a list of rating sub-items by process and a table (Table 6.1-1) of 5 rating criteria common to all processes.

(4) Summarizing and averaging of marks and scores

The marks rated by the experts for 5 to 8 sub-items included in a sub-category were summarized and simply averaged as a score for the sub-category. Such calculations were made for each of 4 sub-categories (A-1, A-2, B-1, B-2) plant by plant.

Based upon the rated scores for the 4 sub-categories, by plant various

analyses were undertaken using the summing and simple averaging method as required for the following:

1) Evaluation by process
2) Technology level of Thai parts industry as a whole
3) Evaluation by owner ship; J/V or wholly owned by Thai capital
4) Features by scale of enterprises

If all 4 sub-categories are averaged into one score, the score indicates a total technology level of the enterprises involved in a group. The following analyses were also done:

Production technology	: Average of A-1 and A-2 (Category A)
Quality control technology	: Average of B-1 and B-2 (Category B)

Hardware section	: Average of A-1 and B-1 (Category 1)
Software section	: Average of A-2 and B-2 (Category 2)

Any scores for any computed by the above processing results in 5-grade rating system because the sub-items, that is the base of all marking, were rated by 5-grade rating and any other scores were obtained by a simple averaging method.

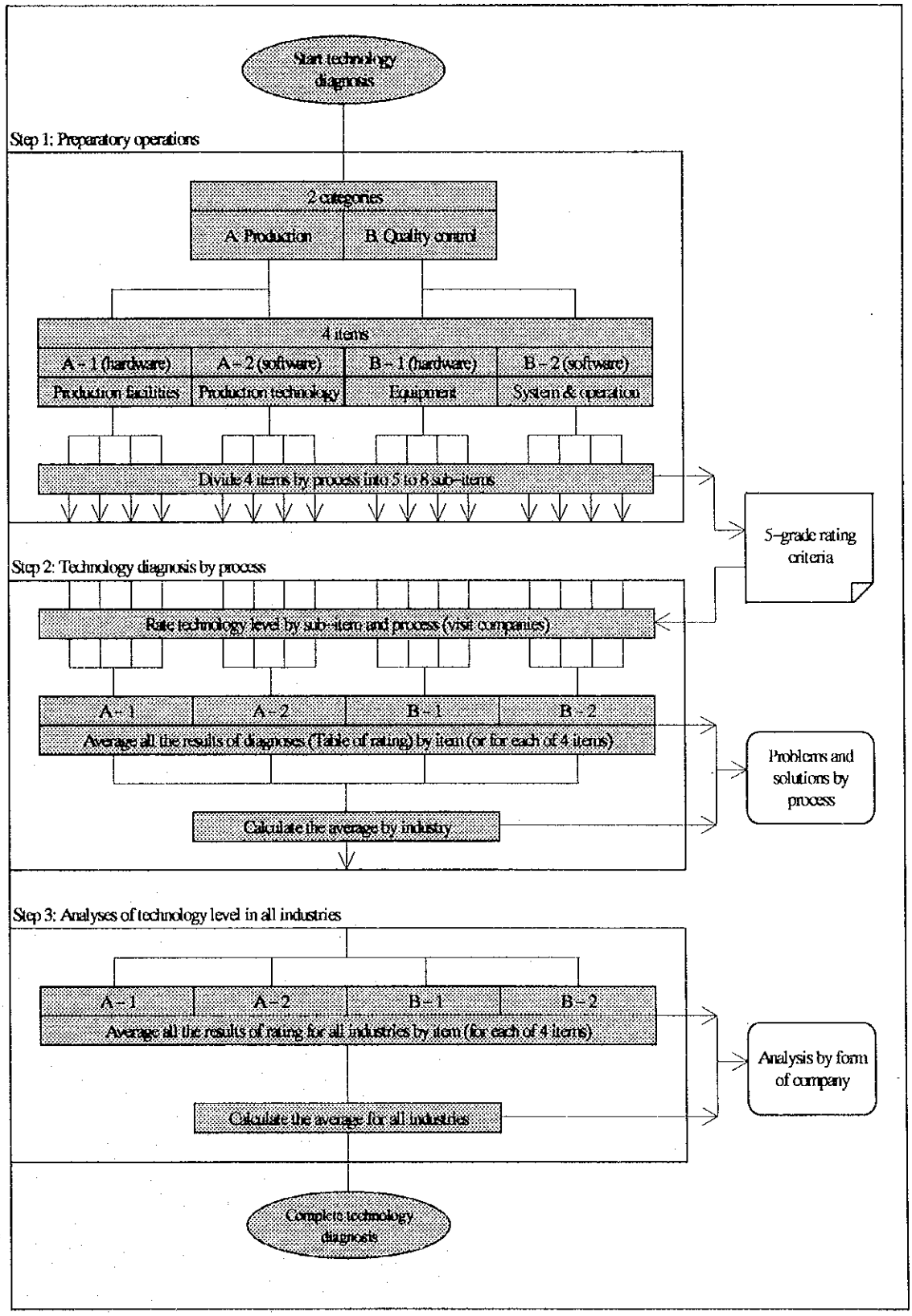


Figure 6.1-1 TECHNOLOGY LEVEL RATING PROCEDURE

6.2 Quantitative Analysis of Technological Level

In this section, the Study Team makes the quantitative analysis of technology level and search for technical problems in Thai parts industries, based upon the results of rating obtained from visited companies. The quantitative analysis by rating may not present the general image of Thai parts industries, for example, because the number of samples is inadequate and different between types of process and between forms of companies. However, The Team believes that this analysis will be able to reveal such problems that the qualitative analysis cannot do.

6.2.1 Assessment of totalized and averaged scores

The Team rated data by technology element for each plant by using the 5-grade rating system as given in Table 6.1-1. In this section, scores by technology element are summed up and averaged from different angles to examine and assess these data. The averages are converted by 5-grade rating into marks, which are shown to the first place of decimals. To assess averages, it is convenient to divide them into several grades. The Study Team adopted 4 grades, A, B, C and D, and set the limits of scores (averages) for each grade as well as the meaning of each grade (Table 6.2-1). The limits of scores for each grade were determined by technical experts through discussions on the results of comparison between all the scores for 56 plants.

The difference in grading between 5-grade criteria for rating (Table 6.1-1) and that for assessment (Table 6.2-1) is caused by the fact that the rating is made by the minus points system from the full mark of 5 points for each sub-item, and on the other hand the scores for assessment are averages of the rating. Even though a plant did not get the full make for all sub-items, there is a case that the plant still has competitive power in international market as a whole. Therefore, some ranges of scores have been set for the assessment criteria.

Table 6.2–1 GRADES FOR ASSESSMENT AND THEIR MEANINGS

Rank	Range of scores	Level	Quality of products available in a plant(1)
A	4.5 – 5.0	OEM International brand, International market	Products are on the average technology level in industrialized countries, and may be directly and indirectly exported as OEM parts.
B	3.8 – 4.4	OEM International brand, Local market	Products are on the upper to top level of technology in the ASEAN area, and may be supplied as OEM parts to J/V. companies with foreign capital but only for domestic market.
C	3.0 – 3.7	OEM Local brand Local market	Products are on the middle level of technology in the ASEAN area, and may be supplied as only for domestic market parts to companies (which have relatively low quality standards) other than those J/V. with foreign capital in Thailand.
D	2.9 and lower	REM Local market	Products are on the technology level on which they may be only supplied as repair parts to the Thai after–market.

Note (1): The range of scores were not set by considering what markets the enterprises are now supplying their products to, but by determining whether or not these plants have a technological level which "generally assures the manufacture of products meeting quality requirements in a market".

6.2.2 Assessment of parts industries by process

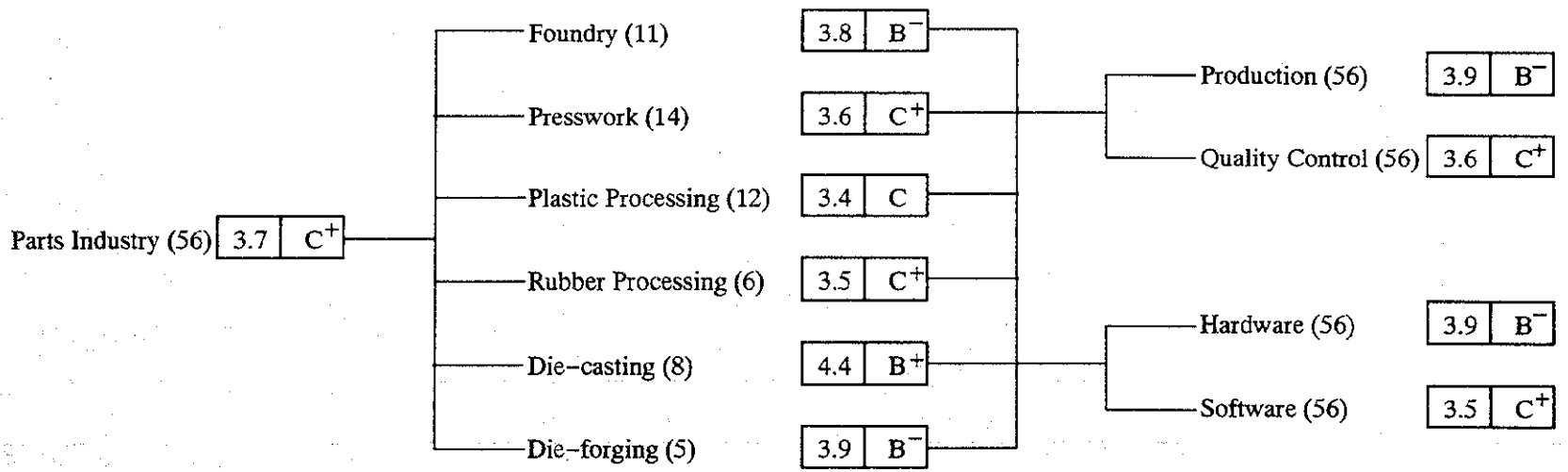
Table 6.2–2 and Figures 6.2–1 and 6.2–2 show the results of rating by process. ATTACHMENT 6–1 gives base data for them showing the results of rating for each individual plant diagnosed. The "parts industries" found in the descriptions below represents the both of autoparts and electrical/electronic parts industries. The following table indicates the general rating scores of parts industries by process in ranking.

Table 6.2–2 SUMMARY OF TECHNOLOGY DIAGNOSIS BY PROCESS

Unit : marks (full mark = 5.0)

Process	Nos. of Samples	A. Production		B. Quality Control		Total-process Average	Hardware	Software
		A–1 Facilities	A–2 Technology	B–1 Equipment	B–2 System		(A–1)+(B–1)	(A–2)+(B–2)
Foundry (Iron & Steel)	11	4.4	3.8	4.0	3.2	3.8	4.2	3.5
Presswork	14	3.8	3.6	3.6	3.3	3.6	3.7	3.5
Plastic Processing	12	3.7	3.3	3.2	3.2	3.4	3.5	3.3
Rubber Processing	6	3.6	3.4	3.6	3.5	3.5	3.6	3.5
Die–casting (Al alloy)	8	4.9	4.3	4.7	3.8	4.4	4.8	4.1
Die–forging (Steel)	5	4.8	3.8	3.6	3.4	3.9	4.2	3.6
Average by Area	56	4.1	3.7	3.8	3.4	3.7	3.9	3.5
		A. Production 3.9		B. Quality Control 3.6				

Source: ATTACHMENT 6–1

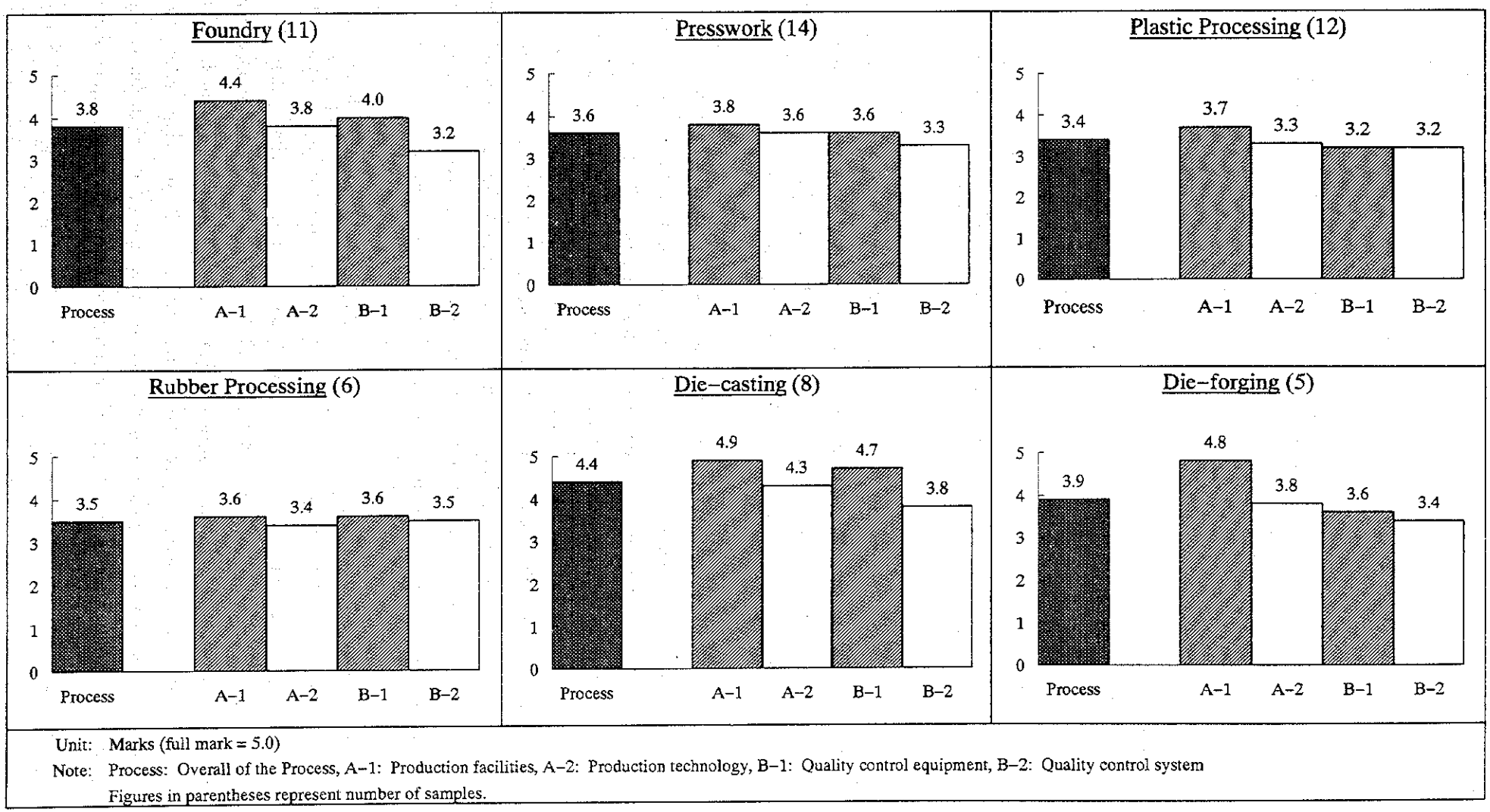


(Note) Figures in parentheses represent number of samples.

Grade A: OEM for international brands and international markets
B: OEM for international brands but domestic markets only
C: OEM for domestic brands and domestic markets only
D: REM (Replacement parts) for domestic markets

(Source) ATTACHMENT 6-1

Figure 6.2-1 SUMMARY OF TECHNOLOGY DIAGNOSIS OF PARTS-INDUSTRY IN THAILAND



Unit: Marks (full mark = 5.0)

Note: Process: Overall of the Process, A-1: Production facilities, A-2: Production technology, B-1: Quality control equipment, B-2: Quality control system

Figures in parentheses represent number of samples.

Figure 6.2-2 GRADING OF TECHNOLOGY LEVEL BY PROCESS

Process	Score	Grade	No. of samples
The whole of parts industries	3.7	C+	56
Die-casting (Al alloy)	4.4	B+	8
Die-forging (steel)	3.9	B-	5
Iron & steel casting	3.8	B-	11
Presswork	3.6	C+	14
Rubber Processing	3.5	C+	6
Plastic Processing	3.4	C	12

(Note) The data in the table are averages by process including scores made by companies in grades A and D.

Average score made by the whole of parts industries is 3.7 (C+). This grade corresponds to a technology level that is slightly lower than the level on which OEM parts of international brand may be supplied to a local market. Grade C+ is ranked as the top of the middle level in the ASEAN area.

In the rating by process, Aluminum alloy die casting made the highest score 4.4 (B+). Grade B+ is positioned between the top level in the ASEAN area and the average level in industrialized countries. This process made the highest score among all processes, because 8 samples include 4 joint ventures as well as 1 local company technically tied up with a foreign maker. Another factor is that the Al alloy die casting technology so largely depends on facilities that the installation of modern facilities may solve a considerably great part of technical problems. The highest score made by this process is also backed up by the average score, 4.9, of 8 samples for production facilities (A-1), as indicated in Figure 6.2-2.

Die-forging with a score of 3.9 (B-) was ranked No.2. Forging is divided into free forging and die-forging which assures the mass production of auto-parts. Thus, 5 samples employing this process include no free forging plant. The number of samples is as small as 5, but adequate, because the MIDI estimated that there are about 10 die-forging plants at most in Thailand. The electrical/electronic industry use few forged parts, and the Thai auto-parts industry does not yet produce forged parts (such as crankshafts and connecting rods) for motor vehicles, but it is now planning the construction of forging plants

to supply autoparts. The 5 sample companies have somewhat small capacity of forging presses which press capacity is upto 2500 tons most of forged auto-parts needs more larger capacity of press machines in general, and produce mainly forged parts for motorcycles and agricultural machines (of small sizes).

One of the factors which contribute to the die-forging ranking No.2 with a high score is that many companies were established in the second half of 1980s and the 1990s to supply forged parts for motorcycles, for which the demand has remarkably expanded in recent years. Companies are still young and new. Another factor is that the forging industry has been well equipped with modern facilities and introduced foreign technologies. These facts are proved by its score, 4.8, for production facilities (A-1) as shown in Figure 6.2-2 as well as its technology level that reaches that in industrialized countries. The weakness of this industry only in quality control (B) causes a difference between this and Aluminum alloy die casting industry.

Iron & steel casing is ranked No.3 with a high score, 3.8 (-B), comparable to that of die-forging. Unlike Al alloy die-casting and die-forging ranked No.1 and No.2 respectively, iron & steel casting attaches greater importance to production technology & skill and quality control than to production facilities. Thai Iron & steel casting technology made a high score and can be considered to be on a high level in the ASEAN area, though it is under the unfavorable conditions that it has a lower dependence on facilities and that 11 samples include only 2 joint ventures (the iron & steel casting industry has a few joint ventures by nature in Thailand).

Aluminum alloy die-casting, die-forging and iron & steel casting technologies in Thailand are now on a higher or top level in the ASEAN area, and may supply parts of international brand to the local markets.

Presswork, plastic processing and rubber processing technologies are rated at 3.6 (C+), 3.5 (C+) and 3.4 (C) respectively, and ranked on a middle to high level in the ASEAN area. These technologies may supply OEM parts of local brand to the local markets. Compared with the 3 top-ranked processes, production facilities (A1) are rated at relatively low scores, which have a reducing effect on the total process averages. From data by process as shown in Figure 6.2-2, it proves that rubber moulding is characterized by an almost same level of scores in 4 items (A. production facilities and B. quality control as well as hardware and software), that

plastic moulding is rated at a low level of scores in 3 items other than production facilities (A–1), and that plastic moulding has low scores in quality control system (B2) that reduce the process average.

Presswork, plastic moulding and rubber moulding technologies in Thailand are ranked on the middle level in the ASEAN area, and may supply OEM parts of local brand to the local markets.

Table 6.2–3 gives the numbers of companies by process and grade.

Table 6.2–3 DISTRIBUTION OF COMPANY BY GRADE BY PROCESS

Unit: Nos. of company

Process	Grade A	Grade B	Grade C	Grade D	Total
Ferrous–foundry	3	4	3	1	11
Presswork	1	4	8	1	14
Plastic Processing	2	1	5	4	12
Rubber Processing	1	1	3	1	6
Die–casting	5	2	1	0	8
Die–forging	1	2	2	0	5
Total	13	14	22	7	56
of which, J/V	8	4	3	0	15

This table indicates that 13 companies (23.2% of 56 samples) have already attained the average technology level (Grade A) in industrialized countries. Of 13 companies, 8 are joint ventures with foreign companies. 14 companies (25.0%) in Grade B include 4 joint ventures. Thus, the total number of companies in Grades A and B is 27 (48.2%), which have a technological force enough to supply OEM parts to companies with foreign capital in Thailand. Grade C includes the greatest number of companies, 22 (39.3%).

6.2.3 Assessment of parts industries by field of technologies

In this section, The Team analyzed the general characteristics of Thai parts industries by technology from the data obtained on 56 samples. Refer to Table 6.2–2.

The scoring of Category A "production sector" and Category B "quality control & assurance sector" (referred to as "quality control sector" hereinafter) is as follows:

A.	Production sector	3.9 (B–)
B.	Quality control sector	3.6 (C+)

The production sector is rated in Grade B– with a score of 3.9, while the quality control sector is in Grade C+ with 3.6. The difference, 0.3, between the two scores is great or equivalent to that between OEM parts of international brand and local brand. It indicates the weakness of the quality control sector.

Categories A and B can be further broken down in hardware and software as follows:

(A–1)	Production facilities (hardware)	6.1 (B)
(A–2)	Production technology (Software)	3.7 (C+)
(B–1)	Quality control equipment (hardware)	3.8 (B–)
(B–2)	Quality control system and its operation (software)	3.4 (C)

Production facilities (A–1) are ranked in the top class within the ASEAN area. Production technology (A–2) is lower by 0.4 points than the facilities and ranked on the upper–middle level in the ASEAN area. Quality control equipment (B–1) is lower by 0.3 points than the production facilities. Quality control system and its operation (B–2) is far lower, 3.4 (C).

The above–shown scores can be summed up and averaged by hardware or software as follows:

Hardware [(A–1) + (B–1)]	3.9 (B–)
Software [(A–2) + (B–2)]	3.5 (C)

These data show that there is a significant difference between hardware and software, weaker. Improvements in software more largely depend on human resources as well as the organization and management of a company than on equipment investment.

Software (A-2), production technology, includes "designing", "casting plan", "Mounting of jigs and tools", "production planning and control", "operation of machinery", "safety", "ability to improve quality of products in order to reduce the rejected ratio" and "researches and development", for which the basic theories of production technology are indispensable. Software (B-2) in the quality control sector includes "inspection on production lines", "inspection for quality assurance before delivery", "feedback of the results of inspection to production lines" and "Total Quality Control (TQC)". There is a close relationship between software in the production sector and that in the quality control sector, which are related to the organization and management of a company as well as human resources.

6.2.4 Assessment of parts industries by form of company

Tables 6.2-4 and 6.2-5 and figure 6.2-3 show the results of technology level rating by scale and ownership of company. The number of samples used in the rating is 56.

A total of 56 samples were divided into 4 groups as follows:

	Ownership	No. of employees	No. of samples
Group 1	100% Thai	199 or less	18
Group 2	100% Thai	200 to 499	14
Group 3	100% Thai	500 or more	9
Group 4	J/V	Whole	15

(Note) The J/V is a joint venture with Thai and foreign capitals, regardless of ownership ratios. The J/Vs include 2 companies with 100% foreign ownership.

Figure 6.2-3 is a set of graphs showing the data in Table 6.2-4. This figure reveals that all the scores are increasing from Group 1 to Group 4 in turn. In overall technology, the group of joint ventures (Group 4) is rated at 4.3 (B+), while Group 1 (199 and less employees) is 3.3 (C). The average of all the 100% Thai companies in Groups 1, 2 and 3 is 3.5 (C).

	Overall technology	Grade
Group 1	3.3	C
Group 2	3.5	C
Group 3	3.9	B-
Groups 1 to 3[1/]	3.5	C
Group 4	4.3	B+

(Note) 1/ Weighted average of samples in Groups 1 to 3.

The greatest difference between Groups 1 (companies on the smallest scale) and 4 (joint ventures) is 1.2 points both in quality control equipment (B-1) and in quality control system and its operation (B-2). Group 1 is rated at 2.9 (D) for Item (B-2), and does not reach even the average in the ASEAN area. The difference between Groups 1 and 4 is 0.9 points in production technology (A-2), and the smallest, 0.7 points, in production facilities (A-1).

Table 6.2-5 indicates the number of companies by grade (A, B, C or D) and form of company. According to the table, the number of companies is 13 (23.2% of 56 samples) in Grade A, 14 (25.0%) in Grade B, 22 (39.3%) in Grade C and 7 (12.5%) in Grade D.

The maximum frequency of grades by group will be examined in the following: Group 4 (J/V) includes 8 companies (53.3% of 56 samples) in Grade A and no company in Grade D. Group 3 (500 employees or more) comprises 4 companies each (44.4%) in Grade B and C, 1 company (11.1%) in Grade A, and no company in Grade D. Group 3 including only one company in Grade A reflects the small number of samples (9), compared with the other groups. Group 2 (200 to 499 employees) contains 7 companies (50%) in Grade C, and 2 companies each (14.2%) in Grade A and D. Group 1 (199 employees or less) includes 8 companies (44.4%) in Grade C, 2 companies (11.1%) in Grade A, and 5 companies (27.8%) in Grade D.

In Table 6.2-5, the greatest number of companies by group is covered with a mesh. This shows that it is in an higher grade as the scale of company is larger.

Table 6.2–4 SUMMARY OF TECHNOLOGY LEVEL BY OWNERSHIP BY SCALE OF COMPANY

Unit: Marks (full mark = 5.0)

Ownership	Thai 100%			J/V *1
Employees	less than 200	200 – 499	500 or more	any scale
Nos. of Samples	18	14	9	15
A. Production				
A–1 Facilities	3.8	4.0	4.2	4.5
A–2 Technology	3.3	3.4	3.8	4.2
B. Quality Control				
B–1 Equipment	3.0	3.5	3.9	4.2
B–2 System	2.9	3.1	3.5	4.1
Overall average	3.3	3.5	3.9	4.3

Note: *1 including 2 companies of foreign 100% ownership.
Source: ATTACHMENT 6–1

Table 6.2–5 GRADING OF TECHNOLOGY LEVEL BY OWNERSHIP BY SCALE OF COMPANY

Unit: Nos. of company

Grade	Range of Marks	Thai 100%			J/V *1	Total (%)	
		less than 200 *2	200 – 499 *2	500 or more *2	any scale		
A	4.5 – 5.0	2	2	1	8	13	23.2
B	3.8 – 4.4	3	3	4	4	14	25.0
C	3.0 – 3.7	8	7	4	3	22	39.3
D	less than 2.9	5	2	0	0	7	12.5
	Total	18	14	9	15	56	(100.0)

Note: *1 including 2 companies of foreign 100% ownership.
*2 Number of employees

Source: ATTACHMENT 6–1

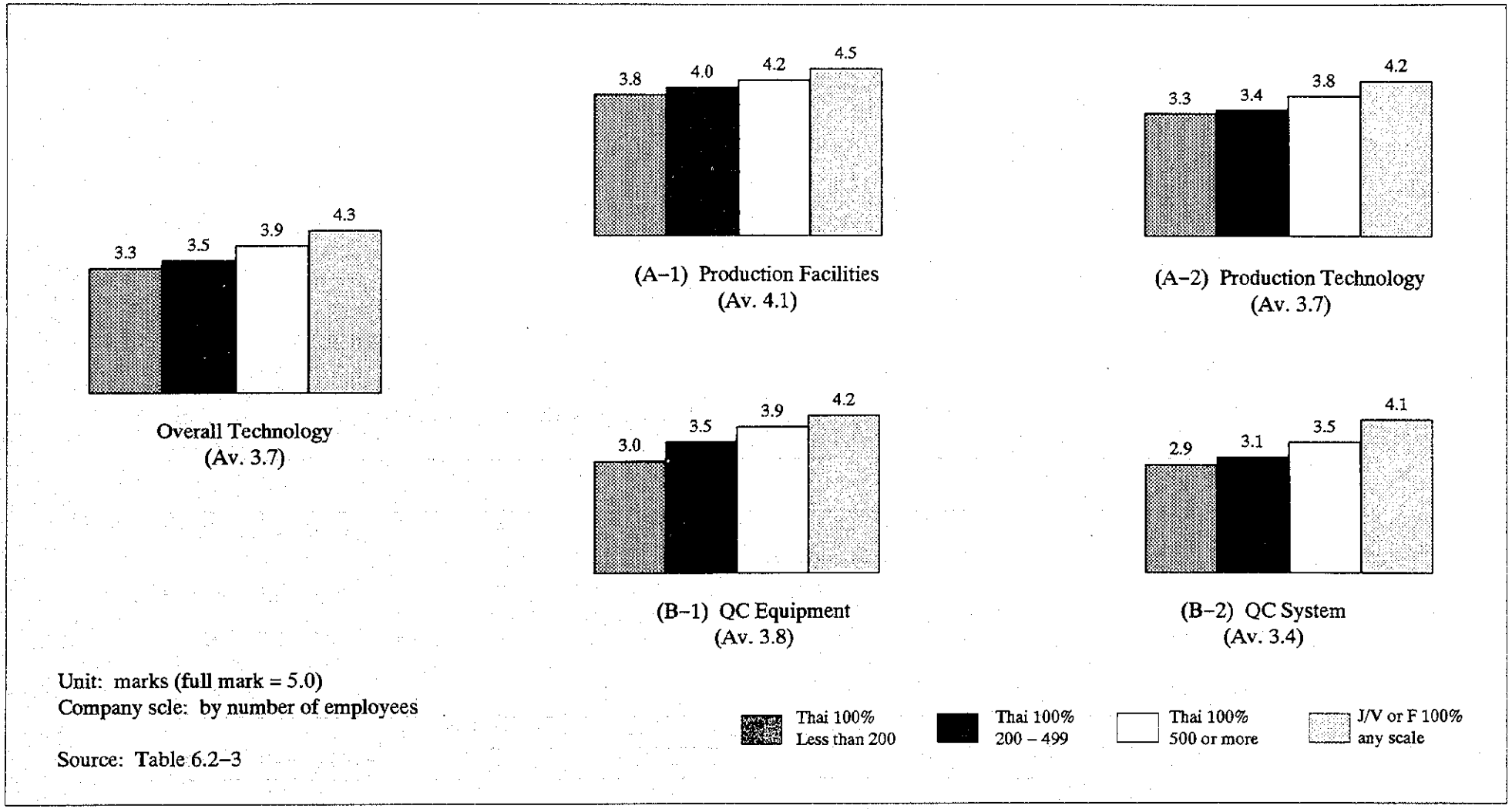


Figure 6.2–3 TECHNOLOGY LEVEL BY TECHNOLOGICAL AREA BY OWNERSHIP AND SCALE OF COMPANY

6.3 Qualitative Analysis of Level of Production Technology

Following quantitative analysis conducted in the previous section, this section analyzes levels of production technology of the subsectors by process in qualitative terms, not covered in quantitative evaluation. The following summarizes the results of analysis conducted by experts in each field for 61 enterprises (including 5 specialized die & mould makers).

6.3.1 Iron & steel foundry industry

(1) Outline

The study team conducted on-site surveys of eleven iron and steel foundries, their users, and other related industrial groups in November and December of 1993, as well as July and August of 1994. Major findings are as follows:

1) The foundry industry in Thailand has seen large growth in production since the late 1980s, due to the combined effect of increased demand from domestic user industries such as automotives, motorcycles, and electrical/electronic makers, and the rise in localization rate.

2) MIDI and industrial sources estimate recent production to be between 500,000 and 700,000 tons annually. As a result, foundry production Thailand alone seems to be a good match for total production in the entire ASEAN region, as judged from recent production trends in the user industries. No detailed production data are announced by the ASEAN countries.

3) As for the OEM parts supply subsector in the iron and steel foundry industry in Thailand, it is still at an infancy stage where primary subcontractors for automotives, diesel engines for farm machinery, and household appliances are emerging, and supply capabilities in this subsector are still insufficient to meet potential demand.

4) Many of foundries wholly owned by local capital produce castings for after-market parts, such as spare parts for automotives and construction equipment, general-purpose pump parts, valves and fittings for water supply systems.

Since price tends to be a more important factor than quality for the after-market products, the local foundries have not built up resources to supply high-grade products targeting the quality-sensitive OEM market. Besides, the after market subsector still enjoy strong demand, so there are no incentive for the foundries, which would otherwise serve as secondary subcontractors, to change their market from REM to OEM.

5) As for product quality, joint ventures with foreign companies and local companies receiving foreign technical assistance offer products that can compete with those supplied by other ASEAN manufacturers. However, more time is needed to catch up with quality levels of industrialized nations.

(2) Major issues

(Issues related to production facilities and equipment: hardware)

1) Generally, facilities and equipment to repair patterns for sand mould making are insufficient.

2) There are large differentials between foundries producing products for the OEM market, and those supplying the REM market, in terms of installation of moulding machines, sand preparation equipment, and sand reclamation facilities. The latter has less equipment in poor working condition compared to the former.

(Issues related to production techniques: software)

1) Few companies have the ability to design moulding patterns, which are thus mostly supplied by customers. This is due to the fact that there are only a small number of engineers or skilled workers in Thailand who have mastered the basics of foundry technology.

2) Green sand mould is most widely used and its quality control is extremely important since it largely influences the quality of castings. However, many foundries do not properly understand the importance of moulding sand control. Some foundries have sand laboratory equipment for moulding sand

control, but do not use it frequently.

3) With the emergence of user industries such as automotives, household appliances, diesel engines for farm machinery, more and more foundries are introducing automatic high-speed and high pressure moulding lines for mass production. Controlling moulding sand for these high pressure moulding machines requires much techniques and efforts compared to the ordinary hand ramming or low pressure jolt squeeze moulding machines. It is therefore important to prevent casting defects caused by mould defects such as weak mould strength, excessive or insufficient compactability, and the popor permeability by carefully manipulating control factors that govern quality of the moulding sand, including grain shape, grain fineness distribution, moisture content, and active clay content.
While various foundries have introduced high-grade moulding machines, many of them are unable to utilize them properly due to the lack of knowledge on moulding sand and its use.

4) The iron and steel casting process involves a much larger number of control factors than any other metalworking processes, and thus much more relies on human skills. On the other hand, there is a shortage of skilled workers in the Thai foundry industry, as well as their supervisors including foremen, technicians, and engineers who can instruct and monitor the workers. The generally low level of foundry production techniques and skills is reflected in frequent occurrence of casting defects.

(Issues related to quality control and quality assurance related equipment: hardware)

1) There are significant differences between foundries manufacturing products for the OEM market, and those serving the REM market in terms of facilities and equipment related to quality control and assurance. Generally, foundries that manufacture products only for the REM markets generally have a lower level of quality awareness. For example, some gray iron foundries do not have a equipment essential for quality control of molten iron, such as CE meters and thermometers, nor sand laboratory equipment needed for controlling moulding sand. And foundries that have these equipment do not use them frequently.

2) Many foundries manufacturing products for the OEM market have insufficient Q.C. and Q.A. equipment high precision including measuring instruments and gauges, and non-destructive testing equipment.

(Issues related to quality control and quality assurance related equipment: software)

1) Generally speaking, a foundry supplying products to customers who conduct strict acceptance tests has a good quality assurance system and operates it efficiently. On the other hand, at a foundry manufacturing products mainly for the after market, the quality assurance system is far from perfect.

2) Few foundries understand or put it into practice the basic concept of quality control, i.e., quality must be controlled in the production process. This is party due to the lack of understanding and concern of foundry owners and managers. In particular, they have little interest in quality control and assurance equipment and auxiliary materials, which do not directly lead to the increase in production, but play a vital role in improving product quality.

(3) Proposed measures to improve production technology

In summary, the major issue facing the foundry industry in Thailand is characterized by the lack of ability to meet rapidly increasing demand for high-quality, highly-reliable castings, in terms of production techniques and quality control. The situation is partly due to generally poor quality consciousness among foundry owners and managers. While continuous efforts have been made, such as seminars on Japanese-style TQC activities held by various organizations, such as TMDPC and the TPA (Japan-Thai), more time is required for Japanese-style TQC to take root, partly due to the different cultural background in Thailand. To raise quality consciousness of managers quickly, an immediate solution is to give them an incentive that will readily lead to business growth, namely an increase in revenues.

Having recognized the issue facing the industry, we would like to propose the following measures:

1) Many top-level foundries in Thailand are interested in obtaining certification for international standards, ISO9000 series in particular, for exporting purposes. Such certification enables them to export their products to industrialized countries, as well as to foreign-affiliated manufacturers operating in Thailand. Thus, efforts to obtain certification should be instrumental in raising the level of manufacturing techniques and quality control of top-level foundry factories to international standards.

2) Thai Industrial Standards (TIS) are classified into mandatory and voluntary standards. Mandatory standards are generally complied with, since companies go out of business without it. On the other hand, few companies are willing to obtain certification for voluntary standards.

   Improving the status of voluntary standard certification, and increasing the number of certified foundries, therefore, would be an effective way to raise the level of the entire foundry industry in terms of production technology.

3) To promote 1) and 2) above, it is vital to make use of the newly completed ISTTC under supervision of the TISI, and the MTC under control of the TISTR.

6.3.2 Aluminum alloy diecasting industry

(1) Outline

On-site surveys were conducted at eight aluminum alloy diecasting factories in November and December of 1993, and again in July and August of 1994. They mainly manufacture aluminum alloy products for automotive parts, motorcycle parts, and electrical/electronic parts by using a variety of processes, such as the pressure diecasting process, the gravity diecasting process, and the low pressure diecasting process. Major findings from these surveys are as follows:

1) The Aluminum alloy diecasting industry in Thailand has undergone rapid increases in production since the early 1970s, driven by fast-growing user industries including the motorcycle industry, the automotive industry, and

the electrical/electronics industry, coupled with the rise in localization rate.

2) As for production of automotive parts and motorcycle parts, Thailand boasts outstanding production volumes among all the ASEAN countries.

3) Most pressure die casting machines now operating in Thailand have rated locking force of 300 tons, and some companies have larger machines with rated locking forces of 800, 1,200, and 1,650 tons. A large number of relatively small machines reflects the fact that demand for diecast parts has been limited until very recently to motorcycle parts, electrical/electronic parts, or small-car parts.

4) Automotive parts and motorcycle parts have sizable after markets, which makes it easier for local companies to produce imitation parts of various brands. For example, imitation engine pistons made in the gravity diecasting process, and aluminum wheels for four-wheeled vehicles and motorcycles under popular brands are rampant on the markets. The major reason for the large presence of imitations is their price – they cost only 50% to 70% that of genuine parts. However, tests show that these imitation parts have extremely low levels of quality and reliability.

(2) Major issues and improvement measures

Compared to the sand mould casting process in the iron and steel foundry industry, the aluminum diecast process is well standardized in terms of work procedures, including selection of raw materials for melting, the melting process, the molten metal treatment process, temperature control of the moulds, and mould wash spray work – and detailed manuals are available. Therefore, there should be no major problems, as long as proper diecast machines and moulds are used in compliance with standardized work procedures.

1) The major issue at present is that the country has to import most of diecasting moulds, mainly due to the shortage of mould designers, and skilled workers for mould making.

2) With the growing demand for aluminum diecast parts, newly formed joint

ventures have emerged for manufacturing diecast moulds as well as plastic moulds. Attracting foreign firms with experience in designing and manufacturing moulds seems to be the quickest way to accelerate the localization process.

6.3.3 Forging industry

(1) Outline

5 forging factories were visited twice between November and December in 1993, between July and August in 1994. All of them produce forged products by processing steel materials in the die forging process and supply them to a variety of industries including automotives, motorcycles and farm machinery. Major findings from these visits are summarized as follows.

1) The steel forging industry, which uses the die forging process, is relatively a new industry that started in the late 1970s with domestic production of diesel engines for agricultural machinery and forged parts motorcycles.

2) The forging industry in Thailand seems to be largest among the ASEAN countries in terms of both the number of establishments and production volume on the basis of rough estimates.

3) At present, major customers are motorcycle and diesel engine (for farm machinery) industries. Encouraged by government policy to promote local production of forged parts for automotive engines, such as crank shafts and connecting rods, there are many projects to build new factories or expand production capacity.

4) Most of forging equipment at major factories are second-hand models imported from Japan, Germany, Taiwan and other countries.

(2) Major issues

1) Compared to production facilities and equipment, those related to quality control and assurance are generally at poor levels. In particular, several factories do not have non-destructive testing facilities and equipment to detect cracks and other defects in the forging process.

2) Production technology levels are generally low, particularly design capability of forging dies. For new products, most of factories use dies furnished by customers.

3) The quality control and assurance system and its management are generally at an infant stage.

(3) Improvement measures

1) As seen in the foundry industry, the major issue facing the die forging industry in Thailand can be summarized into poor quality awareness. Accordingly, one of effective measures is to encourage certification of industrial standards.

2) Also effective will be the introduction of production technologies, and quality control and assurance systems and methods from industrialized countries, which the rise in localization rate of forged parts for automotives. In particular, efforts to improve die design capability are very important.

6.3.4 Metal press processing and press die making industries

(1) Outline

Most of press processing products and dies made in Thailand are consumed by the automotive industry, while precision products used as electrical/electronic components account for a relatively small percentage. In fact, few enterprises are engaged in manufacture of highly precise press dies or high speed and precision press processing.

Of 14 major enterprises in the press processing industry visited during the

on-site surveys, 11 produce automotive parts and 3 are engaged production of electrical/electronic components. Some of press processing makers produce dies in-house as well. In total, 6 press die manufacturers were visited. All of them mainly produce dies for automotive (large) parts.

Overall evaluation of production technology levels of the industry in Thailand indicates that those of automotive parts, e.g., large products such as bodies and panels, are highest among the ASEAN countries, while those of precision parts for electrical/electronic products seem to have a long way for full-fledged development.

(2) Major issues

(Issues related to production facilities and equipment: hardware)

1) In general, many of press machines used in the press processing industry are deteriorated due to aging. Also, many are old types with unknown specifications. On the other hand, large press dies have relatively good quality. Small to medium dies are mainly of obsolete block type.

   All in all, production facilities and equipment of the press processing industry have many problems that impede the improvement of production technology.

   Accordingly, it is critical for the press processing industry to upgrade their production facilities and equipment.

2) Production facilities of the press die industry are rated at relatively high levels. This is particularly true in large dies for automotive parts, but not including precision dies of small to medium size.

   Production facilities for large dies seem to have developed since iron and steel castings - principal materials for large dies for the automotive industry - are locally available. In fact, most of them are equipped with the most advanced production systems ranging from CAD/CAM to MC.

(Issues related to production technology: software)

1) In addition to outdated facilities and equipment, the press processing industry is lagged behind in terms of machine layout, i.e., press machines are not arranged in such a manner to ensure smooth flow of products. Also press work is not performed according to standard operating procedures, resulting in lack of work efficiency and creating work hazards.

   More important, press processing is carried out without accurately determining press force, energy and pressing (pressing) speed, which are fundamental factors of press processing, making product quality unstable.

2) Production technology of the press die industry seems to be maintained at relatively high levels, partly because the factories visited by the Study Team mainly produce relatively simple dies used in the single process, compared to other large dies for the automotive industry. Note that the on-site surveys did not cover production capabilities of dies of complex shape which production have still to emerge in Thailand. Nevertheless, observation at production fields indicates that Thai companies have gained relatively high levels of die production technology. On the other hand, few companies and workers have understanding of fundamental factors in press die design technology, including the role of die structure and drawing bead in the forming process, and limited forming conditions such as die radius and punch radius.

   (Issues related to quality control and assurance – related equipment: hardware)

1) Important quality control factors for the press processing industry are processing characteristics of press machines, precision control of dies, and the need for maintaining workpieces in good condition all the time. These factors affect the quality of press products in the subsequent process. However, quality assurance-related equipment to measure and control these factors emphasize on performance testing of products, while neglecting the press process itself.

2) Quality assurance-related equipment of the press die industry is relatively well maintained in terms of shape, dimensions, and physical properties. On the other hand, the maintenance of equipment used for try test is less satisfactory.

(Issues related to quality control and assurance levels and accuracy control: software)

1) As mentioned earlier, the quality control systems of the press processing industry faces two major problems, the lack of the production management system for the press process, and the absence of the in-line quality control system. As a result, the quality control system is not well or widely practiced.

2) On the other hand, the quality control system of the press die-making industry and its management are rated at relatively high levels. Further improvement can be expected by improving die design capability and the try test system.

(3) Technical upgrading measures

The above issues facing the press processing and die-making industries in Thailand can be viewed as the lack of concern about the need for upgrading production technology levels among factory managers and engineers. In particular, there is an apparent lack of understanding on basic production technology including appropriate application techniques in the press process, which makes it difficult to produce press products with high quality.

Notably, the lack of basic technology affects skilled workers at production fields and leads to deteriorated skills levels. It is observed at all work stages, including process arrangement and setup for the process processing work, analysis of process processing capability, setup for the presswork, the handling of dies, and the establishment of work safety.

The similar problem is seen in the press die-making industry as well. Dies are often manufactured by adopting structural design that does not properly take into account basic press processing technology. Most of them are

imitations of general-purpose designs used in the past, without design modification and analysis of important parts.

Finally, the Study Team visited a press machinery manufacturer. Although it was limited to one manufacturer, the Team's expert on press processing visited the company to make good observation and the company was a leading manufacturer in Thailand, so that information collected from the factory gives a general view of the press machinery industry in the country. The company mainly produces small (20 – 150 tf) mechanical presses (crank presses) and 500 tf class machines upon request.

Specifications for press machines supplied by the manufacturer were analyzed and revealed the lack of detailed considerations including design conditions. In particular, design techniques related to the power drive system, structural strength, and the operation system have not been established well in the preliminary design stage. Generally speaking, production technology levels in the areas of press processing and die-making are governed by functional capabilities of press machines. The relatively low level of press technology seen in the country's leading manufacturer means that there is no seedbed to foster significant improvement of press processing and die-making techniques unless conscious efforts are taken.

Based on the above analysis, improvement measures for the press processing and die-making industries are proposed as follows:

1) To introduce basic press processing technology and disseminate it to the press processing industry, the die-making industry, and the press manufacturing industry. (foreign experts may be used)

2) To promote work safety in presswork by providing necessary education for safety managers and skilled workers. (preferably, a government organization conducts an educational program as well as a certification program)

3) To teach appropriate press processing techniques and skills through training courses conducted by the government.

6.3.5 Plastic processing and mould-making industry

(1) Outline

The study team visited 12 plastic processing shops and 3 mould-making shops (specialized manufacturers) between July 11 and August 9, 1994, and diagnosed their levels of production technology. Note that the plastic processing shops are specialized in injection moulding and some of them have mould-making shops in house.

The plastic industries tend to use commodity plastic resin for plastic processing as much as possible. Accordingly, they increasingly design products based on available resin materials in recent years, rather than selecting a desirable type of resin for particular product design. This particularly true in electrical/electronic components for the domestic market. Large plastic parts for automotives such as bumpers and dashboards are expected to move toward localization in the areas of both die-making and processing.

At present, production capability of large products of the mould-making industry in Thailand seems to be limited to those equivalent to related lacking force of 800 tons of injection moulding machines. On the other hand, the industry is lagged behind in the ability to make small precision moulds due to the lack of precision machine tools and human skills operating them, so that such moulds are all imported at present. While the industry will inevitably move toward production of moulds for very large parts as well as small precision parts, the shortage of skilled operators will likely become a major bottleneck.

Technology levels of the plastic processing industry are roughly classified into two groups. The first group consists of joint ventures with foreign companies or local companies receiving technical assistance from foreign manufacturers, who supply products to foreign-affiliated companies operating in Thailand on an OEM basis, thus referred to as the OEM group. The second group contains local companies who supply repair parts to after markets for various products and focus on cost rather than quality, thus called the REM group.

(2) Major issues

(Issues related to production facilities and requirement: hardware)

1) To evaluate injection moulding machines used by the plastic processing industry, those used by the OEM group are relatively new and are maintained in good condition. These companies are capable of producing small precision plastic products so far as they can obtain suitable moulds.

   In contrast, the REM group uses old machines to reflect the fact that they emphasize low-cost production, rather than quality.

2) As for auxiliary equipment for injection moulding, those directly related to product defect, such as the raw material dryer, do not present a particular problem. On the other hand, those used to maintain product quality (dimensions and physical properties) are insufficient in both quantity and quality. For instance, obvious weakness is observed in equipment related to mould temperature control, coloring and mixing, materials supply, and automatic discharge.

3) Generally, moulds used by the plastic processing industry have the following problems.:

   - Many of them have die plates having varying thickness, with an insufficient number of cooling water pipes.
   - Parting lines are not well formed, probably due to variation of hardness of steel mould and its uneven structure.
   - Moulded products have many burrs partly due to poor finishing accuracy in the mould manufacturing process, and an inadequate injection moulding method.

4) The plastic mould-making industry is generally classified as part of the precision machining subsector. Plastic moulds are manufactured by specialized (contract) mould-making factories or in-house shops within plastic moulding shops. Contract mould shops which are joint ventures with foreign companies or receive technical assistance from foreign companies use machine tools having sufficiently high levels of precision, which are fully utilized by CAD and CAM systems. Some have even introduced CAE systems in an attempt to implement the integrated design system, although they have still to be utilized to their full capability.

On the other hand, in house-mould making shops operated by plastic processing factories are mainly responsible for repairing plastic moulds used internally, and some manufacture new moulds. Thus, most of them do no have machine tools capable of producing high precision moulds, and cannot manufacture new moulds with present resources.

Overall, the problem is characterized by an inefficient use of machine tools in terms of balanced equipment lineup and actual applications. For instance, high precision machine tools should preferably be assigned to tasks with high precision requirements (such as the machining of cavity) in order to maximize productivity.

(Issues related to production technology)

1) The major issue facing the plastic processing industry in terms of production technology is the lack of understanding on basic theory and knowledge in both mould design and processing, which unables the two fields to be effectively interrelated through the common theoretical foundation. For instance, a primary purpose of cooling a plastic mould is to maintain it at a constant temperature, not cooling per se. Mould shops visited by the Study Team do not understand such theoretical background and thus fail to use any mould temperature controller, which is reflected in the following problems:

- An insufficient number cooling water pipes with inadequate diameter, falling long of one cycle time.
- A large difference in cooling water temperature between the entrance and

exist, resulting in uneven temperatures over the mould.

- The inability to keep constant temperature and cycle time, causing uneven product dimensions and properties.

2) The situation is similar in the plastic mould-making industry. Most important, the mould design process does not end in itself. Rather, it has to be considered as the total production process inspeakable from the subsequent moulding process. Efforts to reduce the mould cost become meaningless if they lead to a longer moulding time. Another factor requiring consideration is the selection of mould materials according to the production lot of injection moulding. In Thailand, moulds are still considered to be iron and steel products, rather than high precision products. Finally, there is a shortage of skilled operations who are an important element to ensure the effective use of machine tools.

(Issues related to quality control and assurance-related equipment: hardware)

1) While the plastic processing industry is lagged far behind in this area, there is a notable gap between joint ventures and wholly-owned local companies. Even local manufacturers with the ISO9000 certification seem to maintain only minimum-required facilities and equipment compared to joint ventures. They simply do not feel the need for quality assurance to their customers.

2) In the plastic mould-making industry, large enterprises including foreign joint ventures and wholly owned local companies have sufficient facilities and equipment. On the other hand, in-house mould shop operated by plastic processing company are not equipped with necessary meaning instruments, because they do not feel the need for using measuring instruments for repair purposes.

(Issues related to quality control and assurance systems and their management: software)

1) The plastic processing industry has similar problems in this area. In particular, local enterprises (wholly owned)

- Lack of quality standards, boundary samples, and inspection records
- Lack of practice to notify important points in moulding operation to the operator, e.g., the affixing of the checklist on the machine
- Insufficient measures to prevent the recurrence of "lot-out"

2) In the plastic mould-making industry, local enterprises that have not introduced foreign technology have the following problems:

- Many do not maintain a mould checklist or a mould measurement record.
- Lack of recognition of the need for test moulding before shipment by using own injection moulding machines
- Most of them do not check mould components and parts they made prior to shipment.

(3) Technical improvement measures

Production technology levels of the plastic processing industry are governed by mould design and manufacture as well as plastic processing technologies. In fact, these two elements are inseparable and indispensable.

Small and medium scale enterprises in Thailand, particularly local enterprises, have various weakness to be overcome if they are to evolve into the supporting industry as envisaged under various plans including the present study. Among them, the weakest point is found in the lack of understanding on basic knowledge and theoretical background in industrial fields they are operating, as well as the lack of adequate production resources including equipment and human skills. In this connection, the following strategies are proposed:

1) To effectively teach basic theory on plastic processing through school education, field training, and daily instruction, including the linkage between mould design and moulding technologies;

2) To provide education for factory owners and managers to raise quality awareness and importance of quality control.

3) To provide continuous training for skilled workers through public organizations or joint organizations between the private and public sectors; and

4) To apply a respective theory-and-practice approach to education and training programs to raise the level of understanding.

6.3.6 Rubber processing industry

(1) Outline

The study team visited 6 rubber processing factories in November 1993 and July-August 1994. Major findings are as follows:

1) Historically, the rubber processing industry in Thailand has developed by manufacturing and selling REM parts for after markets. In the 1990s, burgeoning demand for rubber parts used for automotives has caused an increasing number of enterprises to shift their weight from the REM market to the OEM market.

2) At present, the rubber parts market faces supply shortage and many suppliers take advantage of the favorable condition and do not conduct quality assurance inspection for customers. In fact, there are many defect products.

3) Foreign-affiliated joint ventures and local enterprises receiving technical assistance from foreign makers maintain the highest level of production technology among the ASEAN countries. On the other hand, small and medium scale enterprises covered by the present study face a variety of problems. In addition, some of joint ventures with a long history of operation in Thailand have obsolete technology.

(2) Major issues

Notable problems seen in small and medium scale enterprises in the rubber processing industry are summarized as follows:

1) In the area of production, production facilities and equipment including those related to quality control and assurance are below satisfactory levels. In particular, there is an apparent lack of quality control and assurance equipment, and shipment inspection is conducted on a visual basis only. While most of production facilities and equipment are sufficient for making parts for the REM market, but they are not capable of satisfying high levels of precision and quality required for OEM products.

2) Many enterprises procure moulds from outside sources. Any of factories visited by the study team did not produce moulds. A large number of burrs seen at production fields indicates a problem related to mould design and manufacture, particularly accuracy. Also, they do not have machine tools for mould repairing. Thus, most of them operate as contract shops specialized in plastic moulding.

3) Detailed information on blending of raw materials has not been obtained since it is trade secret of each shop. In fact, some shops declined the study team to observe their facilities. In any case, it is easy to tell that their products have high contents of low-cost recycled rubber and natural rubber. Low-cost and low-quality products they are making now may be suitable for the REM market, but not for the OEM market.

4) They face many problems in software aspects such as quality control and production technology. In the rubber processing industry, quality control technology is one of the most important factors in producing high-grade products. Unfortunately, however, facilities that the study team visited fail to meet expectations. For instance, in the blending and mixing process, "blending design" and "quality control on green ware" are only loosely established and practiced. Clearly, this reflects major weak points related to human skills.

5) Many enterprises do not have any quality assurance system nor organization. They perform only appearance inspection before shipment, leaving quality check to acceptance inspection by customers. If any products do not pass the acceptance test, they simply make up for it by making additional supply. Unless such practice is corrected toward the quality-sensitive attitude, the present quality problem cannot be dealt with from it root cause, which is only one effective way to reduce the high defect ratio.

(3) Technical improvement measures

As pointed out above, production practice of small and medium scale enterprises in Thailand remains at the level only suitable for production of REM products, namely serving as low-quality and low-cost manufacturers. If they are to enter the OEM market, the following measures are called for in order to improve their production levels significantly:

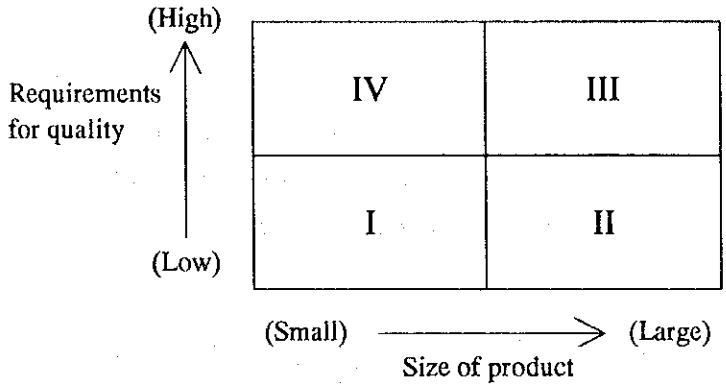
1) Mould production and repairing facilities and equipment should be added to the existing production system. The process should start from introduction of CAD/CAM system, followed by machine tools and measuring instruments.

2) Machinery and equipment related to quality control should be procured, and basic quality control education and training need to be conducted for engineered and workers. In particular, efforts should be made to develop problem-solving ability and experience through practical training to aim at eliminating defect at their own factory.

3) The industry is in urgent need for educating and training engineers and technicians responsible for production management, drawing control, and necessary operations. In particular, factory owners and managers must change their perception of engineers, whose place of work is a production field, not an office.

6.4 Classification of Parts by Level of Production Technology and Positioning of the Thai Industry

This section attempts to classify automotive and electrical/electronic parts by the required level of production technology. As shown in Attachment 6–1, major components and parts are plotted on the portfolio charts constructed for each process to show their positioning. Take ferrous castings, for instance, the portfolio chart is constructed by the following two factors:



(Horizontal axis) Production of castings becomes difficult with increase in product size and/or weight. The horizontal axis represents the size and/or weight of castings that increases difficulty in production technologies from left to right.

(Vertical axis) Here the level of production technology (quality requirements) is scaled from bottom to top.
Quality requirements represent overall criteria governed by a myriad of factors, e.g., material, complexity in shape, the need for heat treatment for forgings.

The two scales on the horizontal and vertical axes vary greatly according to the type of process, such as plastic processing. Note that they do not represent quantitative and accurate measurements of the two factors. Rather they show relative and conceptual yardsticks. Parts plotted in the first quadrant (lower left) belong to the production domain that requires the lowest level of technology, while those in the third quadrant are most difficult to manufacture. Obviously, localization of parts starts in the first quadrant, then moves to the second or fourth quadrant with an ultimate purpose of reaching the third quadrant.

Each chart contains names of components and parts that are plotted in the respective quadrants, and those that can be produced in Thailand are indicated in a shaded area.
In other words, the charts are considered to be a road map for the Thai parts industry that shows the future direction of localization efforts. Major parts that are not currently produced in the country are listed for each process below.

Note that the charts sometimes show parts names other than autoparts and electrical/electronic parts for reference.

1) Ferrous castings

Autoparts :	Cylinder block, Cylinder head, Chill camshaft(1-ton pick-up)
Electrical/Electronic parts :	Nothing in particular

2) Aluminum alloy castings

Autoparts :	Transmission case, Cylinder block, Cylinder head
Electrical/Electronic parts :	Nothing in particular

3) Die-forging

Autoparts :	Front axle(1-ton pick-up), Drive gear, Crankshaft, Connecting rod, steering knuckle, Wheel hub, Small autoparts(rocker arm, shift folk), Engine value
Electrical/Electronic parts :	Nothing in particular

4) Presswork

Autoparts :	Outer panels
Electrical/Electronic parts :	Motor(case, core), Fundational electrical parts(Cam for fine blanking, Dink, Gear, Lever), Precision, electronic parts (IC lead frame, terminal, connector)

5) Press die-making

Autoparts :	Super large size die (upper die weigh > 20tf)
Mainly for	
Electrical/Electronic parts :	Compound die, Progressive die, Transfer die, Die for robotic presswork

6) Plastic processing

Autoparts :	Front and rear spoiler, Fuse box, Bumper, Dashboard, Console box, Front grill
Electrical/Electronic parts :	Washing tub (7 – 8 kg), Telephone casing, Gear & lever, Connector, Coil bobbin,

7) Plastic mould-making

Autoparts :	Bumper, Front spoiler, Front grill, Dashboard, Console box
Electrical/Electronic parts :	Switch box (thin), Washing tub, Air con. housing, VTR mechanical chassis, CD plate, Connector (big size)

8) Rubber moulding

Autoparts :	Semiconductive wire
Electrical/Electronic parts :	CD lens holder