3-2. Taiwan Mold and Die Industry

(1) Development

The Taiwan mold and die industry got off to a late start. Although there were some manufacturers which made molds as well as other products before 1951, true mold and die manufacturers did not appear until after 1964. It is estimated that as of 1987, there were some 2,000 mold and die manufacturers. They are to be found all around the country in the northern, central, and southern regions. Those in the north tend to produce press dies and plastic molds, and in the central region, there are many factories which produce forging molds and molds for shoes. In the south, there are many manufacturers which produce forming molds for bolt nuts.

The majority of the companies are small in scale, and since there are very few medium-sized manufacturers, the remainder are mostly large companies. Press dies are either produced in-house by large manufacturers, or they are made by press die factories. Forging molds are generally produced in-house by forging factories, and there is little subcontracting outside.

With the recent growth of the electronic, plastic, machinery, and metal industries, demand has been created for a large volume of molds and dies. However, the situation still continues in which the Taiwanese mold and die industry is unable to satisfy the demand of domestic users.

(2) Machinery and Equipment and Technical Levels

1) As of 1982, Taiwan still lagged behind advanced countries in relation to the machinery and equipment used for mold and die manufacture. For example, no more than 70 EDM electric spark machines had been installed by 30 companies.

As of 1987, the average mold and die factory used drilling machines, lathes, milling machines, surface grinders, grinding machines, electric spark machines, and profiling machines. The larger factories had CNC milling machines, machining centers, ultrasonic grinding machines, and optical projection machines. Also, some had mold joining machines, 3-dimensional measuring machines, jig borers, and jig grinders.

Only a small portion have adopted CAD/CAM, and it is used in only the design stage. A research facility in Taiwan is presently engaged in developing software.

2) Although the technical level for molds and dies has recently increased significantly along with the development of the electrical appliances, electronic parts, metal parts, and machinery industries, the standard is still inferior to that of Japan and the United States. Design

capacity is far behind that of Japan and the United States, and as such, technology must be improved.

3) It is usual for heat treatment, electric casting, and electric plating to be carried out outside. Small scale factories also depend on outside contractors for wooden molds, 3-dimensional engraving, electric sparking, and mold grinding.

4) The Taiwan mold and die industry has been slow to set standards, and this has contributed to problems in raising precision levels further and to delays in delivery. Because molds and dies are very diversified many difficulties are envisioned in the general adoption of standardized technology. However, the government is currently implementing a science and technology plan in order to achieve standardization.

(3) Labor Situation

1) The mold and die industry is a labor-intensive industry. Training technical experts and holding onto those with experience are significant factors which affect product quality and the amount of time required for manufacture.

Although 20% of the large manufacturers (which produce other products as well) have their own technical courses for training technical experts, these courses do not necessarily focus on only molds and dies. The small companies are not in a position to set up training courses, and 70% of mold and die manufacturers adopt the apprentice system.

3 National Vocational Training Centers have been established in the northern, central, and southern parts of Taiwan in order to train skilled workers. 17% of mold and die producers make use of the training courses provided by the centers.

In addition, there is a system for giving practical training to students from industrial high schools in which the students work in the factories on non-school days. The students are offered scholarships on the condition that they work for the company for 1-2 years upon graduation from school.

2) The number of years of experience of technical experts and skilled workers is an important factor in sustaining the technical level of mold and die manufacturers. In Taiwan, 78% of technical experts working for mold and die manufacturers have more than 3 years experience, and for skilled workers the figure is 65%. According to industry sources, these percentages are rather favorable when compared with Hong Kong and South Korea, where a high ratio of workers change over to other industries. It also shows that the technical capacity of the Taiwan mold and die industry is of a comparatively higher level.

(4) Industry Characteristics

1) The findings of a 1982 survey by the Interchange Association (used below unless where specified) show that in relation to the numbers of employees working in the mold and die industry, manufacturers employ an average of 18 workers, with 60% of companies employing less than 10. Thus, Taiwan is the same as other countries in that the majority of specialized mold and die manufacturers are small in scale.

There are 525 companies which specialize in the manufacture of molds and dies. Of this number, 200 are capitalized at less than 50,000 yuan, and only 26 companies are capitalized at over 10 million yuan.

In 1982 workers employed in mold and die manufacture accounted for 0.5% of the total work force of manufacturing industries. A look at the mold and die industry's share of production value at that time, 0.2%, shows the considerable extent to which the industry was labor-intensive.

2) More than half (55%) of specialized manufacturers produce plastic and rubber molds, and 70% of molds made for plastic products are used in the electronics industry.

30% of manufacturers produce press dies and molds for forging. However, since larger factories are producing their own molds or finish-off molds produced outside due to the importance of precision- and production-timing, the actual percentage of companies producing these molds is higher.

Also, manufacturers producing press dies have become more active due to the introduction of Japanese technology, which has accompanied moves by large Japanese companies, such as electronics manufacturers, to set up operations in Taiwan. This is seen to have improved quality and increased output.

3) Forming companies into a group is important for the development of the mold and die industry. From the perspective of quality and delivery and the keeping of company secrets, users in Japan place great trust in their subcontractors, among which are mold and die manufacturers.

In Taiwan, companies run by Chinese attach much importance to being independent, and due to the relatively low level of loyalty to customers and limited interest in continuing their operations, it is not easy to encourage companies to form themselves into groups.

However, the importance of the supply of molds and dies in Taiwan has increased as a result of increased production activities by Japanese companies. This has brought greater in-house production of molds as well as production by subsidiaries, and in some cases, the subsidiaries are exporting to their parent companies in Japan. Consequently, this should provide

increased opportunities for formation of groups involved in mold and die manufacture, and much is expected of such moves.

(5) Industry Policies

There are no industrial policies which are aimed specifically at the mold and die industry. An outline of general industrial policies is provided below:

1) Included in the 4-year economic plans and other industry promotion policies which were adopted in the 1950s were policies for the development of import-substitution industries and export incentives. Among specific measures taken to develop industry in Taiwan was a system for the rebate of export duties and policies for the introduction of foreign capital.

During the following 20 years, various measures were taken to foster export industries, among which were the establishment of export-manufacturing zones and the implementation of the bonded factory system.

While national projects involving chemical and heavy industries, such as the shipbuilding industry, were promoted during this period, credit guarantee and finance policies were adopted in order to help medium- and small-scale enterprises. Considerable reference was made to Japanese systems in formulating these industry promotion policies, particularly in the case of export promotion policies. In regard to industrial development, the fact was noted that Japanese companies, including the general trading companies, played a significant role.

2) In recent years special emphasis has been placed on promoting frontier industries such as the high-technology industry, and the Xin Zhu Science Estate has been established in order to help develop the hi-tech industry.

Strategic industry incentive policies have been adopted through the 1980s in various ways. The mold and die industry is one industry which has been designated as a strategic industry, and policies have been established for mold and die manufacturers so they can receive guidance from government-appointed committees with respect to finance, equipment, making technological improvements, and business management.

3) In order to encourage companies to form groups with each other the center-satellite factory system was established in 1984 based on the Japanese system, with the function of helping development and other peripheral industries.

This is just one way in which Taiwan's policies differ greatly from those being taken by Hong Kong. Whereas Hong Kong has been successful in adopting a laissez-faire policy to

encourage companies to be independent, there are some doubts as to how successful Taiwan's policies will be for the same Chinese companies.

Although compared with South Korean policy, Taiwan's policy for encouraging companies to form groups is one step ahead as it is being used in the development of the parts industry, but there are some who believe that help from foreign-capital companies will actually prove more effective.

(6) Production

The value of mold and die production increased sharply from 5.0 billion yuan in 1981 to 15.0 billion yuan in 1986, thus showing a 300% growth during the intervening 5-year period. In 1987 production of molds and dies accounted for 0.54% of total production for the manufacturing industries. (Table II-57) This was a 26% increase over the previous year.

Among the different types of molds produced, plastic molds and press dies and forging molds have shown the most rapid growth. (Table II-58) The reason for this is the marked growth of the electronics industry which has been responsible for the accompanying growth of the mold and die industry, one of its supporting industries.

(7) Exports

1) The trade of Taiwanese molds and dies has grown remarkably over the past several years. In particular, there has been a rapid increase in exports, particularly to the American and the Japanese markets. In 1984 exports to Japan and the United States accounted for 27% of the total; in 1987 (January-October), exports to these two markets accounted for 40% of total exports. The significant increase in these 2 markets since then has occurred simultaneously with the overall increase in exports.

With the exception of South Korea, exports to Asian countries continue to be steady, and Taiwanese manufacturers act as suppliers to associated Chinese companies in these Asian countries.

The total trade balance has turned from deficit to surplus, and this trade surplus has been assisted by healthy exports. (Table II-59)

2) Plastic molds account for the larger part of molds and dies for export, and they accounted for 87% of total exports for 1986, which were worth NT$1.62 billion. (Table II-60) Although in the case of high quality products, Taiwanese-made products are inferior to products made by advanced countries both in precision and durability, a comparison of products requiring medium- and low-level quality shows that the price of Taiwanese-made products is

Table II-57. Production of Manufacturing Industries in Taiwan

	Metal Dies (A)		Total for Manufacturing Industries (B)		A/B
	Production in NT$ Million	Index	Production in NT$ Million	Index	%
81	5029	100	2200	100	0.22
82	5658	110	2212	101	.26
83	7059	135	2458	117	.29
84	8687	165	2825	132	.31
85	12278	236	2743	134	.45
86	15062	290	2971	155	.50
87 (1)	17308	343	3216	173	.54

Note: (1)Figures for 1987 are total of November 1986 to October 1987.
Source: Industrial Production Statistics Monthly

Table II-58. Production of Molds and Dies of Taiwan (by Type)

(Unit: NT$1,000)

Year	Item	Production Value of Molds and Dies	Year	Item	Production Value of Molds and Dies
1982	Press and Forging Dies	1,120,806	1985	Press and Forging Dies	2,327,241
	Diecast Molds	371,696		Diecast Molds	771,789
	Drawing Dies	297,357		Drawing Dies	617,431
	Plastic Molds	3,928,541		Plastic Molds	8,157,219
	Total	5,718,400		Total	11,873,680
1983	Press and Forging Dies	1,385,760	1986	Press and Forging Dies	2,952,096
	Diecast Molds	459,563		Diecast Molds	979,011
	Drawing Dies	367,650		Drawing Dies	783,208
	Plastic Molds	4,857,229		Plastic Molds	10,347,403
	Total	7,070,202		Total	15,061,718
1984	Press and Forging Dies	1,671,511			
	Diecast Molds	554,327			
	Drawing Dies	443,462			
	Plastic Molds	5,858,819			
	Total	8,528,119			

Source: Mold and Die Technology Association, "Mold and Die Technology"
Note: Figures are slightly different from those of Table II-57.

Table II-59. Mold and Die Trade of Taiwan

(Unit: NT$ Million)

Exports	84	85	86	86(1-10)	87(1-10)
TOTAL	874	1250	1620	1334	1858
Japan	30	68	177	113	251
U.S.	208	319	465	341	489
Hong Kong	53	139	134	113	225
Singapore	61	59	51	44	68
Indonesia	42	53	123	97	114
Malaysia	71	89	93	74	100
Philippines	51	52	58	50	44
Thailand	80	89	90	70	73
India	38	53	83	73	113

Imports	84	85	86	86(1-10)	87(1-10)
TOTAL	907	1033	1394	1070	1055
Japan	679	781	1085	723	863
U.S.	122	104	178	146	62
Hong Kong	43	45	36	25	28
Singapore	14	45	23	19	19
South Korea	-	-	9	5	22
FRG	18	16	18	18	17
Netherlands	10	16	16	12	17

Trade Balance	84	85	86	86(1-10)	87(1-10)
TOTAL	-33	217	230	264	665
With Japan	-649	-713	-908	-686	-612

Source: "The Trade of China"
Note: Classification: CCCN 8460

internationally competitive. According to an industry source, because Taiwanese products are one-third the price of those produced in Japan, demand for products from Taiwan is increasing.

3) For Japanese manufacturers who are faced with the pressure of having to keep the manufacturing cost down because of the appreciation of the yen, it is becoming more necessary to order parts and molds and dies from overseas. Because, among the Asian NICs, Japan has especially close ties with Taiwan, as it also does with South Korea, it is easy to import goods from Taiwan. In the case of molds and dies, where reliable quality is especially important, Japanese mold and die manufacturers and those in related areas are setting up operations in Taiwan and, as a result, Taiwan, which is making use of the accompanying newly-introduced technology, is in a good position with respect to exports to Japan. In other words, exports to Japan have increased along with the appreciation in the value of the yen.

4) Exports to the United States, Taiwan's largest export market, have continued to increase. The bulk of these exports are plastic molds.

When molds and dies are ordered by users, it is common in the American plastics industry not to send designers to the manufacturers or to provide guidance. When an order is made, a design plan and instruction manual are sent to the manufacturer, who then sends back the mold once it has been completed. Because of this "remote control" type of system, Taiwan is not placed at a disadvantage in regard to mold and die transactions because of the distance between the two countries. There is, therefore, every possibility that exports to the United States will increase in the future. Even in early 1987 exports to the U.S. had already increased.

5) The export of molds and dies to developing Asian countries through links with Chinese companies is steady, and exports to Indonesia and Malaysia are on the increase. An increase is also being seen in exports to India, and demand for Taiwanese molds and dies is expected to increase along with the industrial development of these countries.

6) Although trade between Taiwan and Hong Kong has been developing on a complementary basis, recently there have been more exports to Hong Kong from Taiwan.

The British colony of Hong Kong has been somewhat slow in introducing industrial technology from Japanese companies in comparison to other Asian NIES. In particular, there have been relatively few examples of Japanese companies setting-up operations in Hong Kong involved in related industries such as surface treatment and mold and die manufacture and maintenance. In this respect, Hong Kong is considered not to be as well off as Taiwan.

Table II-60. Imports and Exports of Molds and Dies by Type (1986)

(Unit: NT$1,000)

Type	Exports	Imports	Difference
Press and Forging Dies	95,037	268,736	-173,699
Diecast Molds	90,036	64,051	25,986
Drawing Dies	27,594	4,939	22,655
Plastic Molds	1,407,703	986,184	421,519
TOTAL	1,620,371	1,323,910	1,620,371

Source: Mold and Die Technology Association, "Mold and Die Technology"

Hong Kong industry is essentially a light assembly industry, and in cases in which there is insufficient technology or supporting industries, a pattern has developed in which materials and parts are imported from overseas, thus making use of the advantageous free trade zone.

Taiwan has been putting comparatively more effort into supplying itself to a certain extent, and this, combined with the close relationship of reciprocal Chinese capital between Hong Kong and Taiwan, is one of the factors behind the increase in molds and dies exported from Taiwan to Hong Kong.

7) Although Hong Kong's official trade statistics do not include statistics for mold and die imports from Taiwan which are re-exported, it is reported that products made in Taiwan account for between 15-17% of re-exports (1984-1986). It is also reported that the majority (70-80%) of Taiwanese-made goods re-exported through Hong Kong are bound for mainland China. (Hong Kong Trade Monthly)

Because of the increase in investment in industry in China made by Chinese and foreign companies from Hong Kong, there are high expectations that Taiwanese-made molds and dies exported to Hong Kong will be re-exported to China in the future.

(8) Imports

As for imports, Japan is the country which supplies the largest quantity of molds and dies to Taiwan. As in the case of other Asian NIES, the importation of molds and dies from Japan has increased along with the increase in industrial production and the trend towards higher quality products.

As a result, the balance of trade for molds and dies is such that Taiwan continues to record a deficit. Industries in which Japanese companies play a leading role, such as the high precision product industry and large product industries like the automobile industry, rely heavily on Japan, Europe, and the United States for precision and heavy duty, large molds. As these industries develop further, it is expected that import demand will continue to expand as the supply of molds and dies cannot be fulfilled by in-house production or by outside contractors.

Imports from the United States levelled off in 1987, and imports from West Germany and the Netherlands continue to record the same levels each year. It is therefore expected that Japan will continue to be important as a supplier of high quality molds and dies.

3-3. Hong Kong Mold and Die Industry

(1) Characteristics

1) Although the industry is one which depends on domestic demand, exports have been increasing.

2) The price of molds is low compared to their quality, and the time taken from ordering to delivery is relatively short.

3) There are 1,000 manufacturers which specialize in the production of molds and dies. As 30% of the 3,000 plastic manufacturers have their own mold and die plants, the total number of mold and die factories is in excess of 2,000. Companies which employ fewer than 10 workers make up 70%, and those with more than 50 employees comprise 20% of companies in the industry. Companies which export are mainly those which have more than 50 employees.

(2) Production and Trade

1) The value of mold and die production for domestic use was worth HK$500 million in 1981, and it increased at an annual rate of 24.6% such that in 1986, it was worth HK$1.5 billion. Because exports in 1986 were worth HK$519.55 million, total production in 1986 was worth in excess of HK$2.0 billion.

2) Plastic injection molds account for two-thirds of total output. However, these are mainly medium- and small-size molds, since manufacturers have difficulty in producing large molds and precision molds. Molds for metal stamping accounted for between 20-25% of total output. There is still room for improvement precision stamping and punching molds.

3)Trade

• Mold and die exports from Hong Kong have been increasing rapidly. Compared to an export value of HK$359.36 million in 1985, exports in 1986 rose 44.6% to HK$519.57 million. A further increase was recorded in 1987 when exports increased by 31.2% and were worth HK$681.90 million. (Table II-61)

However, as is shown above, in 1987 molding boxes for molding foundries and molds increased, whereas interchangeable punches and dies recorded a 20.6% decrease over the previous year.

Export results for 1987 show that for interchangeable punches and dies, 50% of exports, worth HK$19.22 million, went to China, followed in order by Taiwan, the United States, Malaysia, South Korea, and Thailand. (Table II-62)

Table II-61. Imports and Exports of Molds and Dies of Hong Kong

(Unit: HK$1,000)

	Item	1985	1986	Growth(%)	1987	Growth(%)
Exports	1. Punches & Dies, Interchangeable (CCCN695413)	39,113.4	50,050.5	28.0	39,737.2	-20.6
	2. Molding Box for Metal Foundry and Molds (CCCN749910)	320,246.9	469,506.4	46.6	642,158.6	36.8
	TOTAL	359,360.3	519,558.9	44.6	681,895.8	31.2
Imports	1. Punches & Dies, Interchangeable (CCCN695413)	53,534.1	84,543.3	57.9	119,647.4	41.5
	2. Molding Box for Metal Foundry and Molds (CCCN749910)	275,381.6	401,287.5	45.7	541,114.3	34.6
	TOTAL	328,915.7	485,830.8	47.7	660,761.7	36.0
	Exports and Import Balance	30,444.6	33,726.1	-	21,134.1	-

Source: Customs Statistics

Table II-62. Main Export and Import Destinations and Origins of Hong Kong Molds and Dies (CCCN 695413)(1987)

(Unit: HK$1,000)

Exports			Import		
Destination	Value	Share	Origin	Value	Share
China	19,924.5	50.1	Japan	71,384.1	59.7
Taiwan	4,915.7	12.3	Taiwan	16,258.4	13.6
U.S.	2,119.1	5.3	U.S.	9,792.2	8.2
Malaysia	1,965.2	4.9	China	7,459.1	6.2
South Korea	1,634.8	4.1	FRG	4,948.4	4.1
Thailand	1,343.8	3.4	Singapore	2,616.2	2.2
TOTAL	(39,737.2)		TOTAL	(119,647.4)	

Source: Customs Statistics

Among exports of metal boxes for foundries and molds, exports bound for China accounted for a substantial amount and were worth HK$368.29 million, or 57.4% of total exports, which were HK$642.16 million. China was followed in order by the United States, Malaysia, South Korea, Macao, Venezuela, Singapore, and Taiwan.

• Imports of molds and dies also increased by 47.7% from 1985, when they were worth HK$328.92 million, to HK$485.83 in 1986. A further increase of 36.0% was recorded in 1987, when imports were worth HK$660.76 million. (Table II-61)

Interchangeable punches and dies increased 57.9% from a value of HK$535 million in 1985 to HK$845 million in 1986. They increased by 41.5% in 1987 and were worth HK$119.65 million. Metal boxes for foundries and molds doubled in value from 1985 to 1987 from HK$275.38 million to HK$541.11 million.

In 1987, 60% of imported interchangeable punches and dies came from Japan, followed in order by Taiwan, the United States, China, West Germany, and Singapore. (Table II-62)

In the case of metal boxes for foundries and molds too, Japan had the most exports to Hong Kong, comprising 32.5 % of the total. Japan was followed by China, Taiwan, the United States, the Philippines, South Korea, and West Germany. (Table II-63)

• Over the past 3 years, the balance of trade for molds and dies has shown a slightly higher amount of exports. This contrasts with the status in Singapore, which has been recording increasing deficits with respect to exports and imports of molds and dies.

(3) Industries Using Molds and Dies

Industries which use molds and dies in Hong Kong are the plastics, metal processing, and the electronic and electric machinery, and equipment industries. As of March 1987, there were some 13,898 companies involved in these industries, and they employed a total of 160,438 workers. In 1986, they exported products worth a total of HK$54.018 billion, which accounted for 80% of annual output. (Table II-64)

(4) Technology

1) Although in the past manufacturers of molds and dies have tended to be conservative technologically, a change in attitude has been seen since the early 1980s, and they have gradually begun to introduce technology. However, because they lack experience in high technology and insufficiently trained technicians, the general rate of introduction of new technology is slow.

Table II-63. Main Export and Import Destinations and Origins of Hong Kong Molds and Dies (CCCN 7749910)(1987)

(Unit: HK$1,000)

	Export			Import	
Destination	Value	Share (%)	Origin	Value	Share (%)
China	368,291.2	57.4	Japan	175,958.0	32.5
U.S.	64,211.6	10.0	China	111,697.5	20.6
Malaysia	25,539.5	4.0	Taiwan	79,767.0	14.7
South Korea	20,621.0	3.2	U.S.	37,475.7	6.9
Macao	18,935.6	2.9	U.K.	20,821.2	3.8
Venezuala	15,149.4	2.4	Philippines	17,442.8	3.2
Singapore	115,029.8	2.3	South Korea	13,259.3	2.4
Taiwan	13,672.1	2.1	FRG	10,241.5	1.9
TOTAL	(642,158.6)		TOTAL	(541,114.3)	

Source: Customs Statistics.

Table II-64. Summary of Mold and Die Users

(Unit: Million HK$)

Users	No. of Companies	No. of Employees	Export Value		Growth Rate
			1985	1986	
Plastic Industry	5,438	84,460	10,337	12,307	19.1%
Metalworking Industry	6,406	63,701	2,936	3,474	18.3%
Electrical Equipment Industry	2,009	112,277	4,551	4,871	7.0%
Electronic Industry			26,962	33,366	23.8%
TOTAL	13,898	160,438	44,786	54,018	20.6%

Source: Hong Kong Commercial Statistics and Statistics of Public Job Security Office

2) As of 1987, there were between 800 and 1,000 electric spark machines in the industry. Wire cut electric spark machines and CNC processing machines are still not commonly used, while CAD is being introduced. Large companies, however, do have electric spark machines, machining centers, and wire cut electric spark machines, etc.

(5) Government Assistance Policies

Organizations which provide assistance in relation to molds and dies are listed below:

1) Hong Kong Productivity Council

This organization is a non-profit organization which was established to assist regional industry. One of the Council's departments is the metal department. Metal specialists and designers work in the department, and they provide guidance on heat treatment and design for molds and dies, as well as evaluation and floating analysis. In 1987 a CAD/CAM center, which houses computers and machine-processing equipment, was established. Educational training courses include CAD services and heat treatment services as well as general and practical courses and a factory practical course.

2) Vocational Training Center

The Kowloon Training Center, established in 1986, includes a plastic industry training center and a precision processing training center. Both centers offer a wide variety of technical courses which range in level from a specialist technician course to a machine-operation course for factory workers. The courses provided are listed in Table II-65.

Table II-65
Courses Offered by Training Centers

Center	Course Name	Period	Annual Student No.s
Precision Processing Training Center	1. Plastic mold precision processing course	44 wks	20
	2. Mold & tool precision processing course	44 wks	30
	3. Plastic mold precision processing course(night)	88 wks	20
	4. Mold & tool precision processing course(night)	88 wks	30
Plastic Industry Training Center	1. Basic course for plastic molding technicians	44 wks	5
	2. Mold manufacturers' course	44 wks	40
	3. Model & sample manufacturers' course	44 wks	35
	4. Plastic injection molding machine course	8 wks	70
	5. Plastic injection molding machine operators' course	4 wks	300

3-4. Singapore Mold and Die Industry

It is not easy to obtain an overall view of the Singapore mold and die industry due to the lack of statistical data.

(1) Industry Characteristics

1) It is estimated that there are between 400 and 500 mold and die manufacturers. Out of this number, between 150 and 200 companies manufacture plastic molds.

2) Although the types of machinery and equipment used by the manufacturers are of a fairly good level, there is a lack of experience in the design and manufacture of molds.

3) Because the level of production technology varies from company-to-company, and it is often not possible to have molds and dies made as requested, it is quite common for users of molds and dies who have the appropriate equipment and technology to produce their own molds and dies.

(2) Production and Trade

1) Production

Although there are no statistics on mold and dies for Singapore and accurate figures are therefore not known, it is estimated that production is equal to about 60% of demand.

2) Trade

Exports were worth S$446 million in 1984 and increased by 37.0% in 1985 to just over the S$600 million mark at S$611.8 million. (Table II-66)

Exports of machine tool dies were mainly to Thailand (34.5% of total), Japan (14.7%), Malaysia (12.8%), and the United States (9.9%). (Table II-67) Molds used in metal casting manufacture, excepting casting molds, were exported to Malaysia (47.4% of total), Japan (8.2%), Hong Kong (7.5%), India (4.7%), Thailand (4.5%) and the United States (4.0%). (Table II-68)

Imports, worth S$184 million in 1984, increased in the following 2 years by 7.3% and 15.1%, respectively, and in 1987, increased by 53.5% over the previous year and were worth S$191 million. As for the major sources of these imports, 1987 customs clearance statistics reveal that machine tool dies came from Japan (74.5% of total), the United States (15.5%), the Netherlands (1.6%) and Taiwan (1.3%). Molds used in metal casting, with the exception of casting molds, came from Japan (62.0% of total), Malaysia (9.6%), the United States (9.0%), and Taiwan (5.8%).

Table II-66. Imports and Exports of Molds and Dies of Singapore

(Unit: S$1,000)

	Item	1984	1985	Growth(%)	1986	Growth(%)	1987	Growth(%)
Exports	1. Dies for Machine Tools (CCCN6954192)	6,570	8,872	35.0	9,439	6.4	10,500	11.2
	2. Molds for Metal Foundry etc Excluding Ingot Molds (CCCN7499100)	38,075	52,312	37.4	53,270	1.8	52,436	-1.6
	TOTAL	44,645	61,184	37.0	62,709	2.5	62,936	0.4
Imports	1. Dies for Machine Tools (CCCN6954192)	38,530	39,297	2.0	46,978	19.5	61,524	31.0
	2. Molds for Metal Foundry etc Excluding Ingot Molds (CCCN7499100)	62,313	68,879	10.5	77,485	12.5	129,523	67.2
	TOTAL	100,843	108,176	7.3	124,463	15.1	191,047	53.5
	Exports and Import Balance	-56,198	-46,992	-	-61,754	-	-128,111	-

Source: Customs Statistics

Table II-67. Main Export and Import Destinations and Origins of Singapore Molds and Dies (CCCN 6954192)(1987)

(Unit: S$1,000)

	Export			Import	
Destination	Value	Share	Origin	Value	Share
Thailand	3,618	34.5	Japan	45,828	74.5
Japan	1,547	14.7	U.S.	9,542	15.5
Malaysia	1,340	12.8	Netherlands	976	1.6
U.S.	1,043	9.9	Taiwan	770	1.3
TOTAL	(10,500)	100.0	TOTAL	(61,524)	100.0

Source: Customs Statistics

Table II-68. Main Export and Import Destinations and Origins of Singapore Molds and Dies (CCCN 749910)(1987)

(Unit: S$1,000)

Export			Import		
Destination	Value	Share (%)	Origin	Value	Share (%)
Malaysia	24,833	47.4	Japan	80,358	62.0
Japan	4,293	8.2	Malaysia	12,396	9.6
Hong Kong	3,920	7.5	U.S.	11,657	9.0
India	2,461	4.7	Taiwan	7,570	5.8
Thailand	2,379	4.5	Hong Kong	4,984	3.8
U.S.	2,111	4.0	India	3,551	2.7
TOTAL	(52,436)	100.0	TOTAL	(129,523)	100.0

Source: Customs-clearance Statistics

(3) Technology

1) Even though the number of employees engaged in the area of molds and dies who have undergone various kinds of training is increasing, there is a shortage of experienced people to provide guidance.

2) In design as well, there is a serious shortage of experienced people so that designers have difficulty in doing what is required, and design takes too much time. This has contributed to delays in delivery.

(4) Promotion of the Industry

The Economic Development Board attaches much importance to the mold and die industry and has been providing assistance to factories through basic technical training.

1) Technical Training

In Singapore, there are a number of centers which have been established to train skilled workers in mold and die technology. These centers have been established with the cooperation of large overseas companies. The majority of managers of mold and die companies and production technology experts have been graduates of these training centers. Details about the centers are listed below:

- Tata Government Training Center was established in July 1972 with the cooperation of the Indian company Tata/Telco.
- Brown Boveri Government Training Center was established in July 1973 with the cooperation of the West German company Tollei. However, this role has now been taken over by another West German company, Brown Boveri.
- Philips Government Training Center was established in July 1975 with the cooperation of the Dutch company Philips.

The courses offered by these centers are included in the Economic Development Board's training course. The training courses run for 4 years, and during the first 2 years, education is provided at the centers. During the following 2 years, training is given in factories. 70-80% of the course is practical, and 20-30% theoretical.

At the end of the first and second years, NTC3 and NTC2 qualifications are awarded, and upon the completion of the fourth year, students qualify for grade 2 of the Craftsman Certificate. (Table II-69)

Table II-69. Industrial Trade Qualifications-Certificates and Training Institutes

	Qualifications-Certificates	Institute
Engineer	Degree	University
Higher Technician	Diploma	Polytechnic Institute
Industrial Technicial	ITC Industrial Technicial Certificate	Institute
Craftman	Craftman Certificate NTC2, NTC3 National Trade Certificate	Training Center Job Training Center of VITB
Operator	Artisan Certificate/ Certificate of Competency (COC)	Job Training Center of VITB

Source: Materials of JETRO

Students must be between 16 and 25 years of age to be eligible for the courses. The following courses are offered at the 3 centers: [1] precision machinery processing; [2] machinery processing; [3] electronic machinery and equipment for general use; [4] electronic machinery and equipment for industrial use; [5] instrumentation and control; [6] maintenance of industrial machinery; [7] mold and die tools; and [8] precision engineering.

The performances of the training centers to data are shown in Table II-70.

In addition, the following training units have been established to provide high-level technical training:

• Computervision-EDB CAD/CAM Training Unit was established with the cooperation of the American company Computervision in February 1983. It provides training in CAD/CAM for mold and die design.

• Japax Group-EDB CNC Training Unit was established in October 1983 with the cooperation of Japax, Ikegai Corporation, and Hamai Industry Co. Training is given in CNC machinery processing.

• ASEA-EDB Robotics Training Unit was established in June 1983 with the cooperation of the Swedish companies ASEA and AB. Training is provided in robotics technology.

In addition, the Mitsutoyo Measurement Training Unit has recently been established.

2) Finance Systems

Although the following systems are not necessarily applied only to the mold and die industry, they are often used by the industry which is a 'peripheral industry' and which has many medium- and small-scale companies.

• Special assistance for peripheral industries (including molds and dies and precision machinery): the Skills Development Fund provides grants to supplement interest payments for loans from the Small Industries Finance Scheme. This system is known as "assistance to achieve mechanization".

• Product development assistance scheme: provides grants to cover 50% of direct development expenses in order to stimulate the development, design, processes, and production of small manufacturers.

• Research and development assistance scheme: provides grants to cover up to 100% of direct expenses for R & D projects that have received approval.

• Technology assistance scheme: aims at medium- and small-scale companies and provides grants to cover up to 90% of the cost of overseas training received for modernization and improving technology.

Table II-70. No of Students in EDB Mold and Die Training Institutes

School	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
BBGTC	96	110	123	114	143	225	253	189	235	158	219
PGTC	-	78	91	92	101	104	100	40	93	78	93
TATA	97	82	88	88	82	161	223	156	210	130	225
TOTAL	193	270	302	294	326	490	586	385	538	366	537
CNC Upper Course	-	-	-	-	-	-	-	-	396	278	300
CAD/CAM Design Course	-	-	-	-	-	-	-	265	531	394	672

Source: EDB

(5) Problems Facing the Industry

1) There is a shortage of information on mold and die technology. There is also very little information from overseas on molds and dies, and such information sources are also unknown.

2) There are many young company operators who have little experience and who have difficulty in solving the problems with which they are confronted. This is also linked to delivery delays.

3) Machines are not used to their full potential. This results from either inadequate production schedules from the use of unnecessary equipment.

3-5. Mold and Die Industry in Japan

(1) History of the Industry

Japan was first able to manufacture molds and dies industrially in the latter half of the 19th Century when machine tools began to be imported from the United States and Europe. Then, during the Second World War, the mold and die industry developed primarily with the munitions industry, and after the war, it experienced rapid growth as mass production systems were introduced during the period of rapid economic growth during the late 1950s.

In 1956 the mold and die industry was included among the industries specified by the 1956 Law on Extraordinary Measures Machining Industry, and then later in 1965, it was one of the industries to come under the Small- and Medium-Enterprise Modernization Promotion Law.(Notes 1 & 2) These moves contributed to promoting the rationalization and modernization of the industry.

Notes:

1) The 1956 Law on Extraordinary Measures Machining Industries involved policies for low-interest loans and special depreciation on machinery and equipment provided by the government.

2) The Small- and Medium-Enterprise Modernization Law entailed low-interest loans by the Medium and Small Enterprise Finance Corporation.

(2) The Industry Today

The full-scale development of the Japanese mold and die industry occured during the latter part of the 1950s during the period of rapid economic growth. Even since the economy entered the period of steady growth which followed the first oil crisis in 1973, the industry has continued to expand. During the period from 1975-1983 when ex-factory value of whole industries increased 1.87 times, that of the mold and die industry increased 3.74 times. The reason for this high rate of growth for the mold and die industry at a time when most industries were slowing down was a higher demand for molds and dies brought about by the development of new products and model changes in most industries.

The mold and die industry has developed in metropolitan areas where there is a concentration of machining industries, the main users of molds and dies. (Table II-71)

Table II-71. Mold and Die Manufacturers Classified According to Type of Product and Location

(Unit: ¥ 1 million)

Area \ Type of Product	Press Dies	Forging Molds	Casting Molds (Includes Die Casts)
Whole country	382,438	17,046	95,112
Osaka	43,990	3,603	8,994
Tokyo	27,322	766	5,893
Kanagawa Pref.	50,764	588	7,922
Aichi Pref.	43,781	2,214	16,770
Saitama Pref.	28,528	1,344	21,483

	Plastic Molds	Rubber,Glass	Other	TOTAL (%)
Whole country	417,090	50,252	143,253	1,105,191 (100.0)
Osaka	59,755	7,632	13,027	137,001 (12.4)
Tokyo	55,563	10,901	16,473	116,918 (10.6)
Kanagawa Pref.	37,633	4,656	11,389	112,952 (10.2)
Aichi Pref.	53,348	4,845	11,878	132,836 (12.0)
Saitama Pref.	32,229	4,593	10,153	98,330 (8.9)

Notes: 1- Based on a survey taken of 7,630 companies with more than 4 employees;
2- The category of "Other" includes other types of molds and their parts and accessories.

Source: "Industrial Statistics Tables- Product Items Edition", MITI, 1984.

Another feature of the mold and die industry is the high proportion of medium- and small-scale companies. As of 1986 there were 12,200 mold and die factories around the country, and 91.2% of this number were small-scale manufacturers with a work force of 19 or fewer. There were only 63 factories which employed more than 100 employees. The reason why there are many small manufacturers is that, in general, a wide variety of molds and dies are produced in small lots such that there is little room for expanding the profit scale.

In recent years the industry has been actively introducing the latest machinery and equipment such as NC machine tools, machining centers, electric spark machines, and 3-dimensional measuring machines. In addition, CAD/CAM systems are being widely adopted among companies which rank at the higher end of the industry. The reason for the greater use of mechatronics in the mold and die industry is that automobile and home appliance manufacturers etc, the users of molds and dies, are making more rigid requests for higher quality, lower costs, and a shortening of delivery time. As a result, the mold and die industry is changing over to becoming a capital- and technology-intensive industry which is reliant on mechatronics.

Of those manufacturers which are increasing production and introducing mechatronics machinery and equipment, an increasing number are faced with the problem of a lack of space in their factories. Also, among manufacturers which are situated in metropolitan areas, there are some whose locational conditions are becoming worse as the surrounding area becomes commercial or is turned into residential housing. Due to the relationship with their customers, such manufacturers are seeking sites which are not far away from their customers and which permit work to be carried out at night. Finding land which meets such requirements is difficult for mold and die manufacturers, however, and there have been calls for the creation of "metropolitan industrial sites" in disused industrial areas in the cities.

(3) Mold and Die Production

1) Production Scale

According to the Ministry of Trade and Industry's "Industrial Statistics" (Industry edition), in 1982 the value of mold and die production was approximately ¥865.0 billion. (Table II-72)

2 factors behind this growth experienced by the mold and die industry are the switch to the product variety, small lot production system by the Japanese economy as a result of the 2 oil crises in 1973 and 1979, and also the development of new products and the shortening of the period of time for model changes.

A look at molds and dies according to type shows that molds for plastic goods form the largest group, followed by press dies. Added together, these 2 types of molds account for more than 75% of total mold and die production. (Table II-73) As is shown in the table, up until 1983 press dies accounted for the largest percentage of total production, with molds for plastic in second place. But since then the rate of increase of press dies has slowed down while plastic molds have continued to increase considerably, so that in 1984 and 1985 molds for plastic accounted for approximately 40% of total production. There are two reasons for this: first, the durability of plastic has improved and its life has been increased, and second, due to the trend of making parts lighter for cars and other products, a switch over has been seen from metal to plastic.

A look at the value of production for molds and dies shows that manufacturers with less than 20 employees produced 45.9% of the total. Companies with more than 20 but less than 100 employees produced 38.6%, and those with more than 100 employees produced 15.5% of total production value. (Table II-74)

2) Structure of the Industry

The manufacture of molds and dies is carried out by manufacturers which have a small number of employees. According to the 1984 "Industrial Statistics Tables", among the 11,181 manufacturers included in the statistics, those with less than 10 employees accounted for 80.7% of the total, and those with more than 10 but less than 20 employees accounted for 11.3%. Consequently, companies with less than 20 employees accounted for 92.0% of the total. Companies with more than 100 employees accounted for only 0.52%.

However, although the number of companies with few employees increased up until 1978, it has shown a slight decrease since 1979. (Table II-75)

The different types of mold and die manufacturers include specialist manufacturers who make molds and dies upon request from their customers, those which produce molds in-house for their own us, and those which fall somewhere between these two types. It is estimated that on average, companies which produce molds and die in-house rely on their own molds for roughly half of their needs. According to the annual reports of Machine Statistics (Table II-76), the proportion of total mold and die production comprised by in-house production has gradually decreased since 1976 and 1977 when it accounted for 29% of the total so that by 1985 it had dropped to 22.6%. This is a significant decrease from the period in the late 1950s when in-house production accounted for 65% of total production.

As for the types of molds produced in-house, forging molds comprise the largest group followed in order by press dies, die cast molds, and powder metallurgy molds.

TableII-72. Production Value of Molds and Dies in Japan

(Unit: ¥ 1 million, %)

Year	Machinery Statistics	Rate of Increase	Census of Manufacturers	Rate of Increase
1972	86,120	—	191,908	—
1973	109,197	26.8	245,290	27.8
1974	110,703	1.4	276,163	12.6
1975	95,361	Δ13.9	272,056	Δ 1.5
1976	121,559	27.5	326,760	20.1
1977	159,001	30.8	406,423	24.4
1978	174,098	9.5	492,419	21.2
1979	201,049	15.5	566,554	15.1
1980	232,464	15.6	674,110	19.0
1981	271,309	16.7	785,924	16.6
1982	297,084	9.5	865,121	10.1
1983	322,574	8.6	1,012,718	17.1
1984	352,650	9.3	1,121,367	10.7
1985	386,710	9.7	1,361,310	21.3
1986	375,498	Δ 2.9	1,304,201	Δ 4.2
1987	356,477	Δ 5.1	—	—

Note: "Machinery Statistics" cover manufacturers with more than 20 employees and "Census of Manufacturers" include all manufacturers.
Δ means minus.
Source: Machinery Statistics Annual Reports, Census of Manufacturers by Industries, MITI.

Table II-73. Types of Molds and Dies and Value of Production

(Unit: ¥1 million, %)

Year	1983		1984		1985		1986	
Type	Value	% of Total	Value	% of Total	Value	% of Total	Value	% of Total
Press	137,667	42.7	135,913	38.5	155,335	39.6	154,911	41.3
Forging	11,108	3.4	11,517	3.3	13,157	3.4	15,099	4.0
Casting	9,028	2.8	10,997	3.1	11,786	3.0	10,706	2.9
Die Cast	31,398	9.7	18,826	5.3	19,512	5.0	19,656	5.2
Plastic	106,152	32.9	142,659	40.5	156,063	39.8	140,031	37.3
Glass	10,618	3.3	11,529	3.3	13,178	3.4	12,952	3.4
Rubber	11,258	3.5	14,130	4.0	15,205	3.8	13,699	3.6
Powder Metallurgy	5,345	1.7	7,079	2.0	7,962	2.0	8,415	2.3
TOTAL	322,574	100.0	352,650	100.0	392,097	100.0	375,469	100.0

Source: "Machinery Statistics", MITI.

Table II-74. Mold and Die Manufacturers Classified According to Size and Production Values

(Unit: ¥1 million)

No. of Employees	Companies		Production Value	
	Number	%	Number	%
1-9	9,725	79.7	360,411	27.6
10-19	1,401	11.5	238,579	18.3
20-29	549	4.5	174,338	13.4
30-49	274	2.3	148,500	11.4
50-99	183	1.5	180,069	13.8
100-	63	0.5	202,308	15.5
TOTAL	12,200	100.0	1,304,201	100.0

Source: "Census of Manufacturers Industry Edition", MITI, 1986

Table II-75. Number of Small-Scale Factories in the Industry

	No. of Factories	Factories with under 10 employees (%)	Factories with under 20 employees (%)
1972	5,950	77.7	91.4
1973	6,090	79.0	91.9
1974	6,243	81.3	92.5
1975	7,144	83.2	93.5
1976	7,409	83.9	93.8
1977	7,684	83.8	93.5
1978	8,709	84.3	93.7
1979	8,977	83.8	93.7
1980	9,231	83.7	93.3
1981	9,934	82.4	92.8
1982	9,874	80.9	92.0
1983	11,494	82.4	92.6
1984	11,181	80.7	92.0

Source: "Census of Manufacturers Industry Edition", MITI.

Compared with these kinds of molds for shaping metals, the ratio of in-house production for molds for shaping non-metal materials, such as plastic and rubber, is low.

3) Comparison of Productivity for Molds and Dies

Compared with the mold and die industries in other countries, the productivity of the Japanese mold and die industry is high. Table II-77 shows a comparison of the sales value per individual employee of the 12 member countries of the ISTA (as of 1981). The table shows that Japan, which was situated in the middle group in 1976 had become the country with the highest rate of productivity 5 years later in 1981. One of the reasons why the sales value per individual worker is high in Japan is that compared with other countries, Japanese employees work longer hours. Compared with Great Britian and the United States, where employees work approximately 40 hours a week, and European countries, where employees work approximately 35 hours a week, employees work 48 hours per week in Japan. Of course, this does not include overtime hours, which are worked in order to meet the production schedules of customers. This is one reason why the delivery time for molds and dies in Japan is short.

Whereas the ratio of annual sales value to investment value in plant and equipment is 13.1% in the United States, 12.2% in Britain, and 10.1% in Italy, in Japan, it is rather low at 6.2%. (refer Table II-78) However, if one takes into account the recent high sales value for Japan, the ratio of machinery and equipment per individual employee is among the highest in the world.

(4) Level of Technology and Future Outlook

1) Production Equipment

Table II-79 shows the machinery and equipment used by the mold and die industry. As shown in the table, 85.7% of manufacturers in the industry have multi-purpose milling machines, 97.9% have surface grinders, 92.1% have lathes, and 90.7% have drilling machines. This shows that the majority of manufacturers have introduced multi-purpose machines. As for measuring machinery and instruments, whereas a relatively high proportion of 65% have projection machines, the ratio of introduction is not so high for tool microscopes and 3-dimensional measuring machines. The rapid increase in NC machine tools has greatly influenced the growth of the Japanese mold and die industry. Because mold and die manufacture involves does not involve only the production of a wide variety of single products, NC machine tools have an undeniably strong impact.

Table II-76. In-house Production Ratios According to Type of Mold

(Unit: %)

Type of Product \ Year	1981	1982	1983	1984	1985
Press	33.8	33.3	33.3	26.9	30.5
Forging	67.7	60.3	64.3	64.0	64.6
Casting	29.5	29.4	33.6	38.5	33.5
Die Cast	25.0	20.3	20.4	34.2	29.9
Plastic	13.6	12.3	14.9	11.2	11.8
Glass	0.4	0.7	0.3	0.0	0.6
Rubber	10.9	9.7	12.5	12.6	14.1
Powder Metallurgy	26.9	26.3	26.3	24.8	26.0
Overall Average for In-house Production	26.1	24.1	25.1	21.0	22.6

Source: Machinery Statistics Annual Reports, MITI.

Table II-77. Average Sales per Individual Employee

(Unit: $US)

Country \ Year	1974	1976	1978	1981
Japan	24,500	21,000	44,000	58,836
USA	33,000	30,000	43,500	50,433
Switzerland	N.A.	32,000	51,949	44,737
Italy	15,000	19,000	27,776	41,992
Finland	20,000	19,000	21,250	39,166
France	23,500	22,500	31,730	38,758
West Germany	21,000	22,500	33,997	37,198
Sweden	22,000	19,000	24,928	35,615
Netherlands	22,000	20,000	35,000	34,000
Belgium	31,000	27,000	33,333	33,800
Denmark	N.A.	N.A.	N.A.	30,933
Great Britain	17,500	13,500	19,141	30,301
Average	22,900	22,320	33,328	39,647

Source: ISTA

Table II-78. Ratio of Investment in Equipment to Sales

(Unit: %)

Country \ Year	1978	1979	1980	1981	Average
USA	21.5	17.5	6.0	7.4	13.1
Great Britain	15.3	19.4	7.9	6.2	12.2
Italy	12.0	8.3	11.0	9.0	10.1
Switzerland	17.2	7.4	5.7	6.0	9.1
Sweden	12.0	6.6	7.8	9.7	9.0
France	11.0	7.9	4.8	3.4	6.8
Netherlands	8.0	5.0	N.A.	N.A.	6.5
Denmark	N.A.	N.A.	5.0	8.1	6.5
Finland	7.0	5.0	3.0	10.0	6.3
Japan	6.0	5.7	6.5	6.7	6.2
West Germany	4.9	4.0	7.3	4.2	5.1
Belgium	2.5	3.0	4.5	6.0	4.0
Average	10.7	8.2	6.3	7.0	8.0

Source: ISTA

Table II-79. Introduction of Production Equipment by Japanese Mold and Die Manufacturers

(1) NC electric spark machine (16.4%)
(2) Wire cut electric spark machine (66.4%)
(3) Multi-purpose electric spark machine (51.5%)
(4) NC milling machine (17.9%)
(5) Multi-purpose milling machine (85.7%)
(6) Surface grinding machine (97.9%)
(7) Molding grinding machine (90.7%)
(8) Lathe (92.1%)
(9) NC lathe (7.1%)
(10) Horizontal milling machine (20.0%)
(11) Drilling machines(90.7%)
(12) Machining center (27.9%)
(13) Transfer press (25.7%)
(14) Three dimensional measuring machine (24.3%)
(15) Universal tool microscpoe (25.0%)
(16) Projection machine (65.0%)

Source: "Japan Mold and Die Journal", 10 May, 1984

The use of NC machine tools, which started in the first half of the 1970s, increased dramatically in the latter half of the decade. Accoding to machinery statistics, there were only 3,312 NC machine tools, which produced ¥51.3 billion worth of molds in 1976 (NC machine tools accounted for 22% of total machine tools), but by 1978 this figure had increased so that there were 7,342 machines producing ¥107.6 billion (29% of total). This increase continued so that in 1979 there were 14,317 machines producing ¥205.5 billion (42% of total), and in 1981 there were 25,926 machines in operation which produced ¥434.1 billion worth of molds (51% of rtotal). Although during the 2-year slump in the economy which occurred in 1982 and 1983 the total for machine tools decreased at a yearly rate of about 10%, the decrease was smaller in the case of NC machine tools. In 1983 there were 26,398 machines which produced ¥426.2 billion worth of molds and the percentage of NC machine tools which were numerically controlled exceeded 60%.

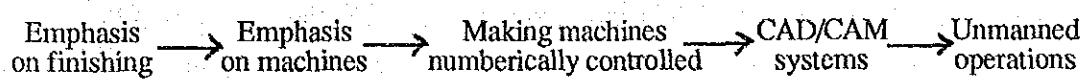
Even though there have been increases and decreases in the most commonly used machines for manufacturing molds, electric spark machines, and machine tools, they have generally continued to increase along with the increase in production in molds and dies.

The trend towards NC machine tools increased sharply so that by 1983 they accounted for more than 90% of all machine tools.

In the May 10 edition of the Japan Mold and Die Journal, it was reported that the wire cut electric spark machine is the machine which the greatest number of manufacturers intend to introduce in the future. It was followed by machining centers and then, among measuring machinery, 3-dimensional measuring machines. This shows that Japanese manufacturers are not satisfied with their present equipment and so intend to introduce the latest type of machinery, such as NC machines, in the future.

2) Design and Processing Technology

The Japanese mold and die industry, an industry which is said not to have experienced bad times, is presently undergoing change. Compared to past performances, the rate of increase in the value of mold and die production is slowing down, and mold and die manufacturers are subject to rigid requests to raise the standard of quality, shorten delivery time, and decrease costs from the companies which use their products. In order to meet such requests, technological changes are being seen in mold and die factories where new technologies such as mechatronics are beginning to be introduced. These new developments are occurring in order to bring about the rationalization of mold and die manufacture, and the various phases involved in this process can be summarized as follows:



In the past, the method for manufacturing molds and dies has mainly involved the manual processing and assembly of parts which have been processed beforehand. But instead of this, most workers now carry out machining by using gauges, and in the case of profiling, they machine by making models. However, this process leads to an increase in manufacturing costs because some time is required for the finishing off process due to a decrease in precision because of errors caused by changes in the temperature of the models and also changes brought about by the passage of time. In order to resolve such problems, methods are now beginning to be adopted which make use of NC functions (e.g. NC grinders, NC milling machines, NC electric spark machines), and CAD/CAM systems. A list of the new developments in mold and die design and in processing is provided below:

- development of electrodes which do not wear much when using electric spark machines
- development of an adaptable automotic control device for use in electric spark machines
- development of a vertical milling machine
- development of an automatic profiling and NC grinder
- development of a NC wire cut electric spark machine
- development of an electrolysis grinder
- manufacture of molds and dies by using CAD/CAM

Automation is also affecting design. CAD/CAM systems have already begun to be introduced mainly among manufacturers who produce molds related to automobiles. The key to using CAD/CAM is software. Although the most preferable situation is to have software made inside a company so that mold and die processing technology is not leaked outside, this poses a problem for small-scale manufacturers. It is because of this that in order to introduce CAD/CAM systems, mold and die manufacturers in Japan are standardizing the various parts which make up molds, the manufacturing stages, and tools and metallurgical tools, as well as putting effort into developing the staff required for computers which use CAD/CAM systems.

3) The Use of Modern Technology and Future Outlook

The most significant change which is expected to take place in the Japanese mold and die industry is the automation of mold and die manufacture and design using the latest technological developments. On top of this, processing technology and machine tools are expected to become more sophisticated. An outline of expected changes is provided below.

First of all there are the advances in the automation of factories. The various types of general machines used for processing molds and dies are gradually becoming automated in order to accommodate variety of small lot production, and in the same way NC machine tools are becoming more sophisticated. Along with the progress which has been made in microcomputers since the latter half of the 1970s, CNC machine tools which apply microcomputer technology are now being used more widely. It is expected that Flexible Manufacturing Systems which manage this will be expanded and will be used even more widely in the future. It is also considered that Factory Automation systems will develop even further and that computers will be used more widely so that they are not used in just the assembly and inspection stages, but used in every stage including the compilation of daily manufacturing schedules.

Second, there is the gradual increase in demand for ultra-precision processing. There is an endless flow of requests for high precision. These range from requests for the normally required degree of precision down to 10 micron units for the general machining industries to precision down to the degree of 1 micron unit for the aerospace and computer industries and even precision down to the degree of sub-micron units for laser mirrors, etc. And for the manufacturing of molds and dies, as a result of increased demand for precision molds, it is expected that the degree of precision of machine tools will increase and that comprehensive research will be carried out involving the development of basic technology for the machines themselves as well as other related technologies and also control technology.

Third, it is expected that technology related to the processing of new materials will be developed even further. One example is recent activity involving the use and development of new materials such as special alloys, ceramics, and composite materials. A new processing technology which is being used more and more in this area is the use of laser processing machines, and in the manufacture of metal molds new technology for processing such as "laminated molds" are being used. It is expected that these new technologies will be applied to more areas in the future.

Fourth, there is the use of new structured materials for the machines which are used for manufacturing molds and dies. Because the machine tool is the most important and fundamental piece of equipment for every industry, and because the machine tools are

based upon the mold and die industry, industries cannot be expected to advance if progress is not made in machine tools. Recently, casting and steel plate welding materials which have been traditionally used for machine tools have been substituted more and more by new materials such as ceramics, concrete, and composite materials. In the case of materials made from concrete in particular, considerable research is being undertaken in this area, especially in Switzerland, and they have already been used for grinders and lathes.

(5) Requirements for the Development of the Japan Mold and Die Industry

1) Cooperative Relationships with Customers

Above all, it is the great importance which is attached to the role of customers who buy molds and dies which has contributed to the development of the Japanese mold and die industry to its present high level.

The first reason why mold and die users are involved in supporting and fostering mold and die manufacturers is the great importance which molds play in the manufacture of their products. The development of new products and new technologies directly concerns molds and dies, and the quality of the molds affects the quality of the products which they produce. Manufacturers cannot manufacture products of a satisfactory quality unless they pay particular attention to molds and dies.

The second reason is that in order to escape from the two oil crises, Japanese companies have put particular effort into developing new products. That is, not only has there been a sudden change over to energy-conserving models for automobiles and home appliances, areas which had constituted the demand sector for molds and dies, but also considerable activity has been seen in the development of new products, largely in the area of electronics and communications.

Also, the consumer buying pattern of the products has shown increasing diversification, and the life cycle of products has been shortened. This has had the result of increasing demand for molds and dies to unprecedented proportions.

As a consequence of these factors, mold and die users have had to put considerable effort into fostering mold and die manufacturers, and they have subsequently been providing all kinds of support, including technological support, financial support, and support in acquiring facilities and equipment. In addition, because mold and die manufacturers have uncomplainingly been supplying customers with molds and dies to meet required delivery dates, a strong bond has been formed between the two.

A third reason is the growth of manufacturers which specialize in the production of molds and dies. Since the end of the Second World War mold and die manufacturers

who have continued to accumulate technology, experience and knowledge. This has made mold and die users recognize that unless they use specialized manufacturers, it will be difficult to procure supplies of good quality molds. For example, even if a mold and die user were to establish its own mold and die division, they would not be able to catch up with the special skills of mold and die manufacturers, so they would have to rely on the mold and die manufacturers for their more important molds and dies, and they would only have to produce molds themselves when the workload of specializwd mold and die manufacturers became too heavy.

As a result, the in-house production ratio of the Japanese mold and die industry (the percentage of the value of molds and dies which users of molds and dies actually supply among the total production value of molds and dies) has been decreasing. Whereas in 1976 and 1977 it stood at 29%, it dropped to 26.1% in 1981, 24.1% in 1982, 25.1% in 1983, and then 21.0% in 1984. This is a significant decrease from the in-house production ratio around 1950, which stood at 65%.

The in-house production ratio in terms of the different types of molds and dies used in forging, casting, and pressing are 64.6%, 33.5%, and 30.5%, respectively. The ratio for molds for glass is particularly low at 0.6%.(refer Table II-76)

There are two reasons why the specialized skills of Japanese mold and die manufacturers are rated highly in this way. First, once technicians and skilled workers belonging to mold and die manufacturers are employed, they normally continue to work at the same company for a long time and accumulate experience in the process. The length of service for mold and die design specialists in Japan is approximately 10 years, and the length of service for skilled workers is nearly 10 years longer than this. What is more, there are many cases where skilled workers stay with one employer for over than 30 years. Such records for length of service also apply for small-scale manufacturers which employ between 5 and 10 workers.

The second reason is that in the early 1970s, assembly industries such as the automobile industry began to grow rapidly, which resulted in a rapid increase in demand for molds and dies. The growth of the automobile industry brought about the growth of the material industry which supplies materials such as special steel, etc., which are used in molds and dies and also led to the growth in the areas of heat treatment and plating, technology which is fundamental for the machining industries. As a result, heat treatment and plating technology, both of which are vital for the growth of the mold and die industry, were resolved at the same time.

2) Growth of Mold and Die Standard Parts Industry

An important factor behind the high level of productivity which the Japan mold and die industry has built up is said to be the role of specialized mold and die parts manufacturers who produce and supply standard parts which make up more than 30% of the parts used in the manufacture of molds and dies. This is because these parts are very useful for mold and die manufacturers who use standardized semi-manufactured goods and standard parts. The greater the range of standardized parts, the easier design becomes. Also, not only is the time required for design reduced, management of the production stages simplified, and the time required for delivery shortened, but it also makes higher quality possible. On top of this, it makes it possible to arrange and systematize the knowledge and experience which usually only technicians and skilled workers have. The use of standardized parts has also provided the opportunity for the introduction of automated equipment such as CAD/CAM, NC machines, machining centers, and robots in areas which were once said to be difficult to automate.

The primary objective of mold and die manufacturers in standardizing parts is to shorten delivery time, and the second is to introduce CAD/CAM (refer to Table II-80). Table II-81 shows that as standardization has taken place, the greatest change has been the standardization of the structure of molds. This seems to suggest that whereas up until today standardization has largely centered around parts, from now on it will focus on software. This clearly shows that a change is taking place from the superficial to the more fundamental.

Today, when the mold and die manufacturing industry is becoming a technology-intensive industry, if the process of achieving standardization itself is regarded as technology, the necessity for each manufacturer to standardize can be expected to increase from now on. What will happen is that standardization will change from setting criteria and patterns over to the standardization of processes and information.

3) Management Improvement and its Direction

Since 1955, when Japan entered its period of real economic growth, demand has increased for goods, particularly for durable consumer goods such as home appliances and automobiles. The raising of productivity has been the primary objective of Japanese mold and die manufacturers, and in order to achieve this they having been putting all their energy into 2 areas.

The first involves raising technical levels through the introduction of the latest types of equipment such as machining centers, NC processing machines, etc., and also by making use of modern technology such as CAD/CAM and robots. At the present time, the ratio of machinery and equipment per individual worker in the Japanese mold and die

Table II-80. Reasons for Standardization of Molds and Dies

(1) Reduces expenses resulting from variety of small lot production (19.8%);
(2) Shortens delivery time (40.7%);
(3) Accommodates changes in design (3.7%);
(4) For the introduction of NC machine tools (7.4%);
(5) For bringing in CAD/CAM (24.7%);
(6) Enables QDC (3.7%).

Source: "Metal Press", January, 1983.

Table II-81. Standardization Process

(1) Use of standardized molds and dies (32.1%);
(2) Standardization of structure of molds and dies (39.5%);
(3) Standardization of processing (17.3%);
(4) Standardization of data (3.7%);
(5) Making units (7.4%)

Source: "Metal Press", January, 1983

industry is around $US9,000, or the highest in the world. The percentage of manufacturers using NC machine tools is also fairly high. While the labor costs of mold and die manufacturers have been increasing significantly, the relative price of NC machine tools has been decreasing, with the result that more and more manufacturers are becoming interested in using NC machine tools. Recently, requests from mold and die users for shortened delivery times and increased precision have become more severe so that the mold and die manufacturers have had no choice but to increase their investment in plant and equipment to raise technical levels.

The increasing use of devices involves the creation of production systems using mechatronics, and the higher the investment in mechatronics becomes, the more important each enterprise's financial capacity will become. Relatively large-scale mold and die manufacturers are making investments in order to put CAD/CAM systems to practical use, and they are aiming at systematizing their operations through the introduction of large NC processing machines. Medium- and small-scale manufacturers who have turned to specializing in particular processing areas are also introducing NC electric spark machines, wire cut electric spark machines, and NC machine tools on a large scale. Also, strategies aimed at the future are being set as, and while on the one hand NC machines are being introduced, on the other hand, in the area of manufacturing, higher precision is being sought, and effort is being put into the manufacture of electronic parts as a result of thorough automation.

Second, the Japanese mold and die industry has a good record in regard to delivery and quality because of its sophisticated production-management systems. Production-management systems can broadly be divided into two types: the integrated system and the division of labor system. The integrated system involves a number of workers making one thing. In this system, the workers produce a mold from the initial to the final stage. The division of labor system entails specializing operations by placing workers at particular production stages or machines.

As for the special features of both of these systems, the division of labor system is a system which enables the continual production of molds and dies at individual stages and also makes it possible for large companies to raise their level of production efficiency. However, if this system were to be adopted by small manufacturers, work would not run smoothly and therefore result in a waste of time. Consequently, small manufacturers are adopting the integrated system which allows for more flexible operations.

Viewed from the perspective of production equipment, because the companies which adopt the integrated system generally have a number of multi-purpose machines, they have to rely on manual work in order to attain a high level of precision and the processing of minute surfaces. On the other hand, manufacturers which have adopted the

division of labor system have introduced a relatively large number of high performance machines, such as machining centers, and molding grinders to achieve a high level of precision. The larger the size of a manufacturer the more the integrated system has been replaced by the division of labor system, and the cut off point between these 2 systems is usually companies which have 10 workers.

4) Recent Trends

The steady appreciation of the yen caused mold and die users to become increasingly severe in their requests to reduce costs, resulting in a 30% drop in the sales price compared to two years earlier. The life cycles of automobiles and electric and electronic goods have been reduced as a result of the diversification and individualization of consumer tastes and this has led to a reduction in the delivery time for molds and dies from 60 days to 45 days in average within a two-year period.

While it looks as though requests from users for a reduction in production costs and shorter delivery time, which have been exacerbated by the appreciation of the yen, will continue, those manufacturers which have managed to keep going by using up their internal reserves and reducing plant and equipment have reached the stage where they can make no more rationalizations. Added to this there are problems concerning personnel as number of young workers entering the mold and die industry has dropped sharply. There are more than a few manufacturers which have gone bankrupt or have entered new industries. They have been put in a position where they have been forced to make new moves in order to stay in business.

One such move is the international division of labor. The setting up of operations overseas by companies within the automobile and electric and electronic industries has been accompanied by increased requests for mold and die production to be carried out overseas. Seeing that there will be further requests for reduced costs and moves to import molds and dies and to shift production bases overseas, mold and die manufacturers will have to take appropriate steps to match such moves.

4. Requirements for the Development of the Mold and Die Industry

4-1 Measures Aimed at Growth

One of the greatest factors which enables any country to build a strong industrial base and to guarantee product quality corresponding to international levels is the capacity to manufacture high quality molds and to achieve self-supply. Today, the worldwide trend is for a gradual increase in the required quality of molds and for a considerably shortened manufacturing time as a result of diversification in consumer tastes and the shortening of a product's life. In regard to this trend, existing machine tools and skilled workers have been stretched to all but their limits with the result that, while holding on to the know-how of existing skilled workers, advanced countries are now changing over to a new type of skilled worker, and they are also putting much energy into changing over to modern plants and equipment. This reflects the considerable extent to which the mold and die industry itself is becoming a capital-intensive industry.

Nevertheless, because the mold and die industry produces single orders, there is a high risk involved in investment in plant and equipment, and excluding a few exceptions, companies are destined to be unable to expand their scale. Therefore, with a limited number of employees and equipment, managing both so there is no waste, companies must continue to accumulate as much technology as possible. A particularly important element for this is technical experts who are required to have a wide basic knowledge of engineering and the ability to adapt that knowledge, and it is subsequently important to realize that it will take a long time to foster such experts.

In order to develop the Thai mold and die industry into this sort of industry, there are many problems today which must be resolved without delay. To raise the level of mold and die production technology, and to quickly raise the level of Thai industrial products overall to an international level, these various problems relating to molds and dies must be dealt with one by one and with no slacking of effort. This requires the establishment of clear goals at both the industry level and also the government level, and the following points will be indispensable in achieving those major goals:

• Rapid improvement in the quality of molds and dies. In particular, improvements must be made quickly concerning the structure of molds and dimensional precision;

• Related to this on the "soft" side is the fostering, in terms of both quality and quantity, of trained engineers with a wide engineering knowledge, and mid-level technical experts to supervise production management, especially technical experts for supervising quality control;

• On the "hard" side, with the increased processing capacity of machine tools, the promotion of old equipment renewal, and the introduction of measuring and testing equipment to meet the improved capacity is required at the earliest opportunity;

• Meeting the needs of customers and building a trusting relationship by shortening delivery times by a large margin and strictly observing delivery dates.

As in the case of the mold and die industries of advanced countries, because with the exception of some standard mold and die parts, it is fundamentally impossible at the present time for the mold and die industry to become an export industry, it is desirable to solve present problems while targeting the increase of the ratio of supply within the country by as much as possible.

4-2 Types of Equipment and Scale

(1) Machine Tools

It is generally said that good molds and dies are made by good machinery and good workers.

To summarize the changes which are taking place in the Thai mold and die industry, lathes and shapers, which up until now have tended to be the main means of production, are being replaced by milling machines. This is a very desirable thing, but in order to make a significant jump, it is essential to replace old equipment with new equipment and to increase the ratio of modern machine tools which are one step higher than current levels.

Taking into account the combinations of machinery and equipment of average Japanese mold and die manufacturers and future trends in equipment, it would be advisable for the Thai mold and die industry to consider making the following changes to equipment over the next five years:

• Lathes and shapers should be gradually phased out and replaced by milling machines and grinding machines;

• The ratio of milling machines should be decreased from the present level to about 30-35%, and as well as replacing old types with new machines, the ratio of vertical types needs to be increased along with the variety of machines;

• To improve processing precision and finishing precision, grinding machines should be increased by 20-25%. Also, other types besides surface grinders which are mainly used today, should be introduced.

In addition to this, although it depends on the types of molds and dies which are being produced, the ratio of EDM and W/C EDM to total equipment should be about 10% and 5% respectively. Also, the installation of jig borers, setting machines and machining centers is required in companies which are medium scale or larger.

In Japan, types of machine tools which have profile functions are being replaced by machines which have NC or CNC functions and also by machining centers. The same sort of change is necessary for Thailand.

Because NC and CNC functions are not always required according to the proposed use of the mold being produced, it is important for each company to examine thoroughly whether or not they are required, even moreso because they are expensive functions. There are cases in Japan where there are limits to the level of precision guaranteed by NC and CNC functions, and there have subsequently been incidents where the NC and CNC functions have been taken out and where skilled workers have looked at the distinctive qualities of the machines and have improved these functions. Therefore,

there is a problem in overestimating NC and CNC functions, and equipment planning which includes their use along with general machines is desirable.

(2) Cutting Tools

It goes without saying that no matter how good the quality of machine tools, if the various types of machine tools are not appropriately looked after and if they are not used correctly in line with the processing purpose, the capacity of a machine tool cannot be used to its full potential. It is therefore essential that the importance of looking after cutting tools be widely recognized, and special testing machinery and equipment and special machine tools for maintenance also shouldbe put in place.

In Thailand it is not necessarily easy to obtain various types of cutting tools. It is necessary to create a supply system where machinable materials and cutting tools which suit individual processing requirements can be freely selected.

(3) Measuring and Inspection Machinery and Equipment

With the increased machine tool processing performance, it becomes more possible to manufacture molds and dies with complex shapes and structures. And also, the more rigid requirements concerning quality become, the greater becomes the necessity for good quality and high performance measuring and inspection machinery and equipment. This must be accompanied by higher standards for controlling and handling such equipment. Because molds and dies are products which are higher in quality and more accurate than the goods which they produce, the range of tools required for controlling quality and precision is more important than raising the capacity of machine tools.

To be able to respond to this, it is imperative that the level of interest shown by company managers in investing in measuring and inspection technology rises in accordance with the rate of growth of the industry. It is also necessary for a wide range of information to be supplied to enable the correct selection of measuring and inspection machinery and equipment, and for instruction in inspection and measuring technology and related control technology to be of the same level.

4-3. Technical Experts and Skills

(1) Increasing Design and Drafting Experts

According to statistics by the Ministry of Industry in Thailand, the proportion of mold and die companies which do not have staff who are involved in design and drafting is increasing rapidly, and moreover, this proportion already accounts for more than 50% of companies. Because design is the basis on which things are built, this trend could well become a major obstacle in the development of the Thai mold and die industry. For example, even if the customer were to supply mold plans on top of the usual product plans, with the exception of simple molds, it is still essential to use plans to examine methods which will make production easy and moreover, as inexpensive as possible in line with the processing order and methods which correspond to the capacity of each particular company's equipment. And, having done so, it is essential to reflect and develop assembly plans and detailed plans from the plans which were furnished by the customer.

Because in general the commercial value, quality, and cost of manufactured goods are for the most part decided in the design stage, and because the know-how required for this is accumulated at this point, the task of increasing the number of general design and drafting experts is not something restricted to just the mold and die industry, but is clearly an urgent task which must be undertaken by the whole of Thai industry which is promoting industrialization.

Consequently, accompanying the the expansion of Thailand's entire industrial sector, many more facilities for educating and training people who are capable of carrying out design and drafting are required, and measures must also be taken to expand the base for potential design and drafting experts. This can be easily done by industrial high schools and technical institutes. It involves taking measures aimed at increasing the number of such education facilities and student places, as well as planning and implementing short-term training courses for technical instructors with national qualifications. Short-term training of instructors has been carried out in the past in Japan as a part of industry-related policies, and a training course for technical instructors established within a university engineering department (a three-year course to attain technical instructor qualification) and the implementation of similar policies would achieve practical results.

(2) Raising Technical Level of Design and Drafting

The technical experts who are currently in charge of design and drafting in companies will no doubt have to play a key role in order to produce molds and dies which

are of passable quality as well as those for use in manufacture which are high in quality, accurate, complex, have a high degree of productivity, and can compete with international products. It is therefore important that this group is constantly exposed to environments where they can acquire a wide range of engineering knowledge relating to the basics, as well as the latest in mold and die technology, and also knowledge relating to production and equipment.

Because within Thai mold and die companies there is a shortage of people who would be qualified for providing instruction to this group, this task cannot easily be carried out by the companies themselves. Therefore, in the immediate future it will be necessary to place particular emphasis on expanding methods for instruction through the use of a combination of experts from overseas and official organizations such as MIDI.

(3) Positioning of Production Management Staff and Objectives

The function of production management is closely related to the quality and delivery problems which confront the Thai mold and die industry. Although it is possible to adopt a special system and to have full-time management staff in companies which are large in size, mold and die companies are generally small and find it difficult to deal with these problems in any systematic sort of way. Thus, the task of supervising these tasks falls to the operators of these small companies or staff who have other jobs within the company. In Thailand's case, added to the difficulty of carrying out production management under the single order production system, there has always been a low level of recognition of the importance of production management so that even today the ground has not been prepared for carrying out production management according to modern methods. Furthermore, the methods for production management vary from company to company, and general information which is provided through seminars, etc., is insufficient.

Therefore, the most realistic answer lies in the involvement of an organization which is able to teach the OJT system at actual production sites. A practical means of achieving this is to arrange for the transfer of technology by staff who have had actual experience in production management in overseas mold and die companies. This is also an urgent task, and it is important that preference is first given to the management elements which are closely related to quality and delivery.

(4) Creating Skilled Mold and Die Workers

The importance of skilled workers in the true sense of the term has long been keenly recognized by countries such as Japan which have capital-intensive and equipment-intensive type companies. Even though it may be that the skills of skilled

workers have been transferred to machines, manual dexterity has been absorbed by machines, and the experience of staff is expressed in design plans and recorded on NC tapes, there are still occasions when only skilled workers are able to unravel the mysteries of the technology of molds and dies. In Japan it is said to take 10 years at the very least in order to raise the level of general workers to that of skilled workers. The stages which are required for this process are as follows:

Stage 1: Period as an apprentice. Able to operate machine tools. Learn about the structure of single shot molds;
Stage 2: Able to use machine tools freely. Learn how to assemble single shot molds. Able to attach single shot molds to presses and molding machines;
Stage 3: Able to put together single shot molds alone;
Stage 4: Able to put together single shot molds thoroughly. Able to put together simple automatic molds;
Stage 5: Able to assemble common automatic molds;
Stage 6: Able to put together complex automatic molds.

Only with the existence of skilled workers produced in this way will theoretical processing methods such as NC, CNC, and DNC become possible, and will it also be possible to solve problems which can't be solved through theory alone.

If the present situation peculiar to Thailand continues where, on the basis of a few years of practical experience, employees training to be skilled workers break away to form their own small workshops, causing an accompanying outflow of workers, it will be difficult to produce true skilled workers or to maintain fixed numbers of such workers.

Because it takes time to produce skilled workers, long-term measures are all the more necessary. Although the improvement of companies' employment conditions, which include the wage system and a system relating to welfare, are given as requisites for achieving this, the situations vary from company to company, thus making it difficult for the private sector to deal adequately with this problem on its own.

The introduction of a system for public technical qualifications covering a wide range of occupations is a possible means for treating companies and individual skilled workers equally and also for making effective use of the increased level and accumulation of skills. By introducing such a system the principle of competition would function so as to make companies take steps to acquire qualified staff and improve remuneration in accordance with their qualifications. Also, if the skills of general skilled workers received their just social recognition, there would be more interest in technical training, more technology would be accumulated, and technical levels would increase, albeit gradually.

As for the present situation regarding a certification system for technical experts, in 1987 the North Bangkok school of the King Mongkut's Institute of Technology (KMIT) introduced a course modelled on the West German "Meister" system. The aims of this course are to foster highly qualified technicians and to award the students who complete the course with the institute's own certificate on passing practical, theoretical and oral examinations given by five instructors.

The ten-year course is divided into three stages of 3, 5 and 2 years, and is aimed at employees of private companies. During the first 3 years the main emphasis is on practical skills and they are taught along with some theory at the KMIT 4 days a week. For the remaining 2 days of the week the students work at their companies. During the following 5-year part of the course the students return to their companies where they carry on with their jobs and at the same time also absorb the curriculum material which is asssigned to them by the KMIT. Students are given tests to see if they have learnt the assigned material. Then for the final 2 years of the course the students return to the institute where they study by taking a number of different courses which include a mold and die course.

The practical part of the course starts with such basics as filing and scraping and progressively becomes more difficult and ends up with high-level processing technology. The theoretical part of the course covers a wide range of subjects including mathematics, processing theory, metal science, the principles of measurement, drafting, labor laws and ethics. For each year of the course there are places for 40 students and the institute expects to award about 15 students with its master certificate each year.

At the present time this master certificate system is carried out by KMIT alone, but in order to have a certification system for technicians which is widely adopted there is a need to have this approved as a national qualification as soon as possible. Also, KMIT's curriculum places considerable emphasis on education starting at the beginning, and as a result it takes a long period of time in order to become qualified. It is therefore also desirable to establish a public organization for providing qualifications and offering short-term training courses for people who already have some qualifications and who have had some degree of practical experience. A practical step would be for MIDI to become involved in this, and in doing so it is necessary to expand its educational function as well strengthening its ties with the KMIT.

It would also appear that KMIT is faced with a serious shortage of experienced teachers to provide instruction to the students. It is therefore necessary to set to work at once to produce more instructors and to increase opportunities for having instructors and prospective instructors taught by overseas technical experts and for sending instructors overseas for training. The appointment of people from the private sector should prove an

effective means of filling this gap in the short term. However, if this is done it will be necessary to consider the matter of appropriate remuneration for such personnel.

4-4. Management

(1) Management Ideology and Strategy

With the exception of a few medium- and small-scale companies which have dealings with companies which export or with the in-house production divisions of large companies with close ties with the manufacturing export industry, the majority of company managers have little interest in making reforms with regard to any aspect of their operations. This may be because of the favorable situation of the industry. To give some concrete examples, they have no interest in putting management resources into expanding their companies, creating new customers, renewing equipment, or raising technology levels, and tend to adopt a continually passive attitude. Consequently, future plans are not worked out, and those that have been formulated lack detail.

It is an industry which sells technology and skills, and in order to stimulate those involved into action, the supply of information from overseas and educational activities are needed to enable managers to get a clear view of their own company's technical level by way of comparison with the situation and trends of overseas mold and die industries. Then, on the basis of such comparisons, they can establish a management ideology and strategy for the purpose of making progress.

As for the state of their companies, rather than continue as they are today with low quality molds produced at random upon requests from customers, it is necessary for each company to build for itself a system which looks ahead to the near future. The following are suggestions taken from examples drawn from the experiences of most of the mold and die companies in Japan today:

- Put energy into producing special high value added molds and dies using a combination of expert technology and skills;
- Specialize in specific areas for which there is the required expertise, such as becoming processing, finishing, or parts manufacturing producers;
- Make the company one that puts effort into stabilizing business, manufactures products which include molds as a means of accumulating mold design and production know how, and sell only molds and dies.

By making individual companies adopt detailed management plans which correspond to each company's situation in this way, it is possible to build a management ideology and strategy as well as to raise the technical level of the industry as a whole.

This should largely be achieved by establishing, under governmental direction, an organization which can provide management guidance to medium- and small-scale companies, and with the cooperation of the private sector (including experts from the private sector overseas). In order to activate management, it would be effective to form a

joint public and private industry organization for providing information on mold and die related technology, machinery and equipment, and market product trends both in Thailand and abroad, and for matching demand and supply and for coordinating with governmental organizations.

(2) Maintaining Human Resources

In reality, the ability to hold on to capable staff depends on salary levels. This was backed up during the course of the interviews when it was found that the higher the salary level, the easier it was to hold on to staff and the lower the rate of resignations. However, it is not possible to simply attribute this to salary levels since the situations differ from company to company.

Judging from past examples, measures which could be applied to the Thai mold and die industry are the scholarship system and the company education subsidy system. The scholarship system for guaranteeing staff would work by being implemented at the private level where an industry group or specific companies award a scholarship or provide a loan to students for the course of their studies on the condition that they work for the industry or for the specific company providing the scholarships upon the completion of their studies.

The company education subsidy system for re-educating company employees is a system whereby companies in government-designated industries receive government subsidies to cover the equivalent of labor costs, or partial labor costs, for the hours not worked while employees undergo education and training within or outside the company. As such, it is a system which assists the development of those designated industries.

However, it is more effective for middle-level engineers and above, the expected managing staff in companies, and training staff who are engaged in educational institutions, to carry out both management training and technical education by entering the work place and coming in contact with the real situation where possible. It is therefore necessary that the government take measures so that people with overseas study experience, who today work mainly as researchers or government officials, are spread more widely among the private sector so they will be able to receive practical training at the companies and training institutes overseas.

(3) Management Through Calculations

Most Thai mold and die companies which are not used to a management system which involves making calculations will have to prepare data based on calculations relating to all aspects of their operations if they are to become more concerned with the quality of molds and to rigidly observe delivery dates in the future. In particular, because

molds and dies are manufactured goods which have a high level of added value, if company earnings are to be guaranteed, it will be all the more necessary to set fixed and correct criteria on which to base the costs of their products and to revise such criteria regularly. This requires an analysis of operations by employees involved in directly related divisions, an analysis of the operation of machinery and equipment, and getting hold of figures for past performances relating to total expenses for indirectly related divisions, the cost of equipment depreciation, development costs, and the average volume of goods in stock. In addition, it requires a broad understanding of the situation of the company itself through calculations, and at the same time having available data related to operations which make it possible to set the cost of each mold ordered according to a fixed set of criteria.

4-5 Production and Technical Management

(1) Design

1) Mold and Die Manufacture Based on Design

Design determines the quality and cost of molds and dies and the productivity of products. The way in which manufacturing processes are put together and the difficulty of processing and assembly are also greatly affected by design. It is therefore urgent that the Thai mold and die industry creates an awareness of the importance of building a production system which is centered around design. From the time when product plans and samples are received from the customer, a series of fundamental steps must be taken in order to make molds and dies which are internationally competitive. These involve consulting with the customer on the method to be used and eliminating as many problems as possible in order to receive the customer's consent, then in the actual design stage, including the customer in examining possible technology and production methods on the basis of design plans, and on the basis of corrected plans, carrying out production management to ensure that the required quality can be achieved.

2) Producing the Required High Grade Design Experts

Design experts who can instruct general designers and draftsmen, who have a wide engineering knowledge, who have a comprehensive engineering background, and who are thoroughly familiar with how mass production works are required in order to bring about a change in attitude as described above. Because such high level design experts are only produced after receiving tertiary education followed by sufficient practical experience within industry, a long period of time is required for this process. As this is virtually impossible for general small and middle scale companies to achieve, it would be worthwhile to tackle this task by using an industry organization or through cooperation between companies which make molds and dies and those which use them. Examples of some possible steps which could be taken are government assistance through policies related to providing scholarships or loans to outstanding students and providing designers working for companies the opportunity to study in Thailand or with a company overseas. It is also necessary that these design experts take part in the business operations of the company to a certain extent, and preferential treatment in the area of remuneration is also required.

3) Importance of Thorough-Going Design

When designers are involved in the actual process of design, company criteria which have been set by individual companies, or the industry, as well as various types of

official standards and criteria, are of more practical use than their own engineering knowledge is. In particular, a company's own standards and criteria for design which correspond to the company's technical level and equipment capacity have a considerable influence on the quality of design, the efficiency of design and the maintenance of quality standards. This standardization of design is indispensable for building a data base and software for CAD/CAM systems which are expected to be introduced on a sizeable scale in the future. Some examples of items which have to be standardized are listed below:

- List of design plans, delivery schedule of plans, and control table for plans;
- Rules for drawing up plans and standards for marks and symbols;
- Standards for structure of molds and positioning of parts;
- Standards for the partition of molds and dies;
- Plans of standard mold drawing;
- Materials suitable for each quality level, classification of maximum processing precision;
- Standards for surface treatment;
- Sandards for mold strength and calculations on degree of deformation.

Because the task of standardizing these items requires the accumulation of technology covering all aspects of a company, it is something which companies are not expected to be able to do straightaway. Thus, a relatively easy means would be to seek the assistance of experts from overseas for the fundamental parts.

(2) Equipment Planning

The important points in planning equipment are the renewal of old equipment and the introduction of adequate measuring and inspection equipment. However, because this requires costly investment, bold policies related to governmental assistance and the financial loan system are called for. In general, Thai mold and die companies tend to carry out the major processes for mold and die manufacture within the company and as this requires a substantial amount of equipment, it proves rather difficult to renew equipment. Therefore, it would be desirable, under close government guidance, for companies to form themselves into groups or to organize themselves into some kind of industrial estate. This would enable the joint utilization of processing machines and measuring and inspection machines, and the division of labor of the processing stages which will make the renewal of equipment easier and raise the operation ratio of equipment.

Nevertheless, in the case of molds and dies no matter how high the performance of automatic processing machines, tasks such as the processing of minute parts or the

finishing of the surface of molds cannot be done even with the latest in available technology. In the finishing process of polishing, in particular, machines are not nearly as effective as humans. In this regard, full advantage should be taken of the advantages of the characteristics of the Thai people who are very skilful with their hands, learn quickly, and are patient. Therefore, when making plans concerning equipment, attention should not only be focussed on the introduction of expensive machinery; rather, the formulation of plans which utilize the high quality and abundant work force as a precondition would be better suited to Thailand.

(3) Planning of Production Process

In the case of Thai mold and die manufacturing companies, the task of highest priority in the establishment and management of the production process for each mold is the guarantee and shortening of delivery.

The planning of the production process starts with the accumulation and then analysis of past production performances, and on the basis of this the statistical compilation of information and figures for use in future production. This makes it possible to set the scale of production, the amount of raw materials to be brought in, production schedules, and delivery dates. These naturally become criteria for making cost calculations, and moreover, make it possible to plan the receipt of orders. The following are necessary as basic data:

- Standard processing time for each machine tool
- Standard working time for each manual process
- Table of ratios for actual work
- Table of ratios for irregular working hours
- Table showing comparison of past processing efficiency levels

By synthesizing these data it is possible to formulate basic and detailed production schedules as well as an overall production schedule for controlling the coordination of separate mold manufacturing processes. This will lead to dispatch of firm work orders to individual processing stages and workers, and should prove effective as a first stage for being able to meet delivery requirements. After having reached this stage, it would be worthwhile to branch out into other areas which greatly affect processes and also require management, such as procurement, metallurgical tools, maintenance, and subcontracting.

Because the management of the various stages differs from company to company due to the differences in the types of molds and dies handled, equipment, and the composition of their work forces, and also because expertise is required, in the immediate future it would be practical to send experts to each company to give instruction which corresponds to the conditions of each particular company.

(4) Attaching Significance to Quality Control

A large-scale campaign aimed at the whole of the Thai mold and die industry which teaches the basic concepts and importance of quality and quality control starting at the beginning needs to be carried out urgently. Running parallel to this, it is necessary to start providing functional management which can raise quality levels. Some important elements in quality control are the setting of correct criteria for the processing order and the processing methods required for molds and dies, and putting such criteria into written manual form as well as seeing to their implementation. In addition, adequate equipment related to inspection and testing and the maintenance and control of tools is also required.

Although the setting of standards and making standards will have to be done with the help of experts from overseas, because it is the Thai people who are the ones who will put this into practice, it is important to take into full account the Thai way of thinking. In instances where the conditions regarding control or attitudes are different, it is a good idea to put things in such a way that they can be easily changed by Thais. Also, because quality control reverts to the question of the quality of the people who are responsible for its supervision and management, it is not possible to change the perception of quality by only standardizing the means of achieving quality. In order to see international quality levels and how they are attained first hand, it would be effective to send technical experts in charge of quality control and also those in management to overseas companies for practical training.

(5) Stable Supply of Materials

In historical terms the supply industry in Thailand has a weak base and imports are relied upon for the majority of materials. As advances are made in producing molds and dies which are high in quality, increasing the types of good quality materials available and establishing a prompt delivery system will become increasingly important. Because lots are small even in the case of generally used materials, it is necessary to push down the purchasing unit price of materials which are comparatively expensive and to improve the system for materials which are hard to get hold of so that they can be delivered promptly. An effective means of achieving this would be joint purchasing by a company group, or for an industry group to handle materials and other sundry supplies.

4-6. Standards for the Manufacture of Molds and Dies

Although companies which place particular importance on standards make up the minority in Thailand, as companies develop so that they are able to undertake all stages from design through to manufacture themselves, whether or not they recognize the importance of standards will become an important factor in relation to their technical capacity. In this sense, the expansion of the contents and the scope of Thailand's Industrial Standards (TIS) is important.

It is difficult for the average company in Thailand to obtain information on the industrial standards of individual countries or international standards, and once obtained they require translation. It is therefore necessary to establish a system whereby a government organization or an industry organization collects the various different types of standards, translates them, and then provides the necessary parts to companies for a fee upon request. This is related to information services which will be referred to later on.

Although a company's own standards should be established by the company itself, for standards which are common to the industry, a committee could be established in the East Asian region within an industry organization to examine those standards. Liaison with the Japan Die and Mold Manufacturers Association, as a member of the International Special Tools Association (ISTA), would also be useful.

4-7. Supporting Industries

The findings of the survey conducted in Thailand show that problems lie in the fields of material supply, heat treatment and plating. The former area was dealt with above. As for heat treatment, it will probably become necessary to introduce heat treatment furnaces and vacuum furnaces with the capacity to handle large molds. An increase in facilities with functions for the accurate regulation of furnace temperature and automatic temperature recording will also be required. Furthermore, upgrading of the tools, facilities, and test equipment required for the finishing process after heat treatment is necessary.

Concerning heat treatment technology itself, there is a need for the dissemination of basic heat treatment methods, that is, a basic knowledge of heat management technology and atmosphere management in furnaces for a given material and heat treatment specifications. In addition, the training of specialized technicians possessing a knowledge of metallurgical fundamentals (e.g., the relationship between hardness and changes in the metallic structure, judgement of materials from the metallic structure, and the relation between metallic structure and heat treatment properties) is necessary.

Plating is an important mold processing step that directly affects mold lifetime, molding properties, and product appearance. The increase of chrome plating capacity in particular is critical not only for the improvement of mold and product quality but also for the development of Thailand's metal goods industry as a whole. The expansion of total treatment capacity will naturally be required, but it will also be necessary to enlarge treatment facility capacity to allow the handling of large parts. Concerning facilities, the installation of inspection facilities that will allow local firms to carry out management of the crucial plating agents is needed. Here as well, the training of plating specialists must be undertaken as soon as possible. In particular, more electrochemical surface treatment technicians with the ability to apply chemical analysis methods, sampling methods, and pre-plating surface treatment and chemical handling methods are needed. In any case, both the heat treatment and plating industries have the capability to resolve these problems with those for the mold and die industries.

4-8. Obtaining and Sharing Technical Information

The bringing together of the industry in an organized way is desirable if the Thai mold and die industry is to make a combined effort to raise technology levels and to create a firm base for industry in Thailand. Looking at examples from other countries, it would seem that in order to achieve this, a private industrial organization should be formed with the participation of the government and research organizations, which would be run with the cooperation of companies. The following are examples of the main activities which would be undertaken by such an industry organization, which should focus on the bringing together of the mold and die industry including members of the supporting industry and the mold users:

- Publication of a bulletin
- Collection and exchange of general technical information
- Translation and presentation of overseas technical information
- Statistical survey activities related to the industry
- Market surveys and statistical estimate surveys
- Coordination of standards and establishment of new standards
- Study of business and factory management
- Creating a consensus within the industry

In order to put these activities into practice, various committees should be established within the organization such as an international committee, technical committee, standards committee, and committees for different technological areas. It is

also necessary to vitalize the organization by carrying out a variety of specific activities on such committees.

Other activities which need to be undertaken by the organization are coordination with the government on industrial policies and liaison activities with overseas groups, as well as providing an information service aimed at companies within Thailand involved in the area of molds and dies.

In the next stage this should be followed by the establishment of an institute which would have as its objectives the raising of technical levels in just Thailand and measures aimed at future technology. These would be accompanied by the fostering and expansion of highly qualified technicians and researchers. The presentation of research findings, overseas research trends, and technical surveys at a high level and the sharing of recent technology does not stop at just the industry level, but is important for looking into the future as an industrialized country.

4-9. Adequate Steps for Technical Knowledge

Mold and die technology combines a wide range of specialist technologies centering around metal processing technology and has rigid requirements for precision and durability. What is more, it is not restricted to metal processing technology alone but must also take into account technical know-how related to plastic processing materials (various types of plastics and mainly metal plates), instrumentation engineering, machine phenomena related to presses and molding machinery used for manufacturing products, and information technology aided with computers. Few industries must deal with such a broad range of related technologies.

Ideally, all technical experts involved in mold and die manufacture should share an across-the-board knowledge of technology in general. It is sufficient, however, for each individual to acquire the technological know-how related to his own area of expertise. It also goes without saying that managers and others in charge of the supervision and management of technology should be familiar with as wide a range of knowledge as possible. In achieving this, it is important to acquire engineering know-how through a good education and foster adaptability through practical experience. Similarly important is self study through the repeated practice of both of these while keeping pace with technological progress.

The reason for the importance of the re-education of technical experts within and without the company is to be found here. In particular, unremitting efforts need to be taken in relation to the problems of mold precision, materials, structure and processing

methods where advances in technology and innovations to equipment take place at a fast rate. This is true as well for the industries which suuport the mold and die manufacturers.

Consequently, a society-wide effort to upgrade technical education, including basic technical education at secondary technical and vocational schools and the securing of human resources therefor, advanced technical education at the universities as well as training in the application of this knowledge, and an increase in training opportunities for members of the work force, is needed. There is also a need for the reassessment of education policies with the object of promoting industry by broadening the pool of human resources and supporting "leading groups" of advanced specialists. To start with, capable leaders and teachers must be secured at each stage of the educational process.

5. Problems and Countermeasures

(1) (Problem) Lack of Organization within the Industry

[1] It is important that the modernization of management and the improvement in technical levels in the mold and die industry be carried out through associations formed between manufacturers and users. As a supporting industry for mass production industries it is vital that the mold and die manufacturers have links with their customers.

[2] But despite this, it is the practice of Thai mold and die manufacturers not to carry out business activities, and instead to wait until users contact them. It is no exaggeration to say that as a result they have no knowledge of the user market. Also, it was learnt in the course of the interviews that the manufacturers do not exchange opinions relating to business and technology.

[3] One reason for this is that the mold and die industry is a seller's market as it is swamped with many orders, and so there has been no need to undertake activities aimed at increasing business. However, the rapid increase in investment from overseas which has been, and is, continuing to take place in Thailand has seen some manufacturers change their attitudes and make improvements in technology and increase the extent of contact with the market in response to requests from users among overseas companies operating in the country.

[4] Amidst such trends calls are starting to be heard from within the industry for the establishment of a mold and die industry association which would facilitate an exchange of opinions on the topics of technology, types of machinery, the market, etc. MIDI is currently examining setting up an industry organization which would serve as a channel for information.

(Countermeasures) Developing an Industry Organization

As it would prove difficult for the organization of the industry to be carried out at just the industry level, assistance from the government is also required.

The possible functions and composition of groups are set out below:

- The establishment of an office within MIDI to produce a publication which would contain articles on domestic and overseas technology, markets and business. (This would be done as a starting point for the formation of an industry group.)

- Assistance with information, the setting of targets aimed at technical levels for the industry, and the implementation of various sorts of training carried out by an industry organization.
- Manufacturers are very keen to purchase expensive machinery such as EDMs. However, if one takes the amount of use into account such machines would not always very cost effective. Therefore, efforts should be made to promote the joint purchase and joint use of expensive machinery.
- Due to the occasion of the Trade Conference by Commodities (Mold and Die) which is to be held in Singapore in October 1988 the Japan Mold and Die Industry Association is planning to seek the formation of an organization to link its association with those of Indonesia, Singapore, Malaysia, the Philippines, Thailand and Hong Kong. The objectives of the organization are to provide information, resolve problems, and to involve itself with the resolutions of the ISTA.

(2) (Problem) Lagging behind in Management and Technology and Insufficient Information

[1] The majority of companies are not accustomed to management systems based upon calculations. Because molds and dies are manufactured products which have a high added value, it is all the more necessary to guarantee company profits by following quantitative, and also legitimate criteria to attain that added value, and to renew calculations which form the basis of control at regular intervals. In order to do this, it is necessary to grasp and accumulate data related to average stock volumes, development expenses, the cost of depreciation of indirectly related divisions, and to analyse the work of employees engaged in directly related divisions and also the operation of machinery and equipment. An understanding of the company itself is also required along with the accumulation of such data to enable the setting of costs for each individual order received.

[2] There are very few companies which carry out sales activities. This is attributed to brisk business for mold and die manufacturers and the fact that it is a seller's market. However, the lack of sales activities make it impossible to recognize the significance of materials, required durability, precision and the use of product images, and make it difficult to increase the scope of design and manufacture. It also means that the manufacturers themselves are cutting off a means of obtaining market information.

[3] There is little interest in obtaining information. It is rare for manufacturers to show an interest in information on general technology, market and demand estimates and standardization.

(Countermeasures) Improving Management and Technology and the Provision of Information

Business management based on calculations and the accumulation of information are indispensable in the modernization of business. As long as a company's accounts are the same as household accounts and only sense and experience are relied upon, there is little hope of improving or developing business. As possible means of solving this the following activities could be carried out by the government or industry groups. (These can also be applied to quite large manufacturers.)

- The collection of data and information and improving services for the provision of such information;
- Increasing and improving business consulting, and training for managers;
- Holding seminars on the various types of technology;
- Inviting experts to provide technical guidance and training for private companies;
- Inviting overseas manufacturers to Thailand and promoting the formation of joint ventures.

(3) (Problem) Shortage of Technical Experts

The weak industrial base which is the result as well as part of the process of industrial development in Thailand has meant that companies have not produced adequate numbers of technicians and skilled workers, with the result that there are many manufacturers of molds and dies which rely on experience alone. As well as there being few companies which carry out production and design based on engineering knowledge, the level of this for those that do manage to do this is not high.

The situations of the respective occupations are described below:

[1] There are few companies which use design divisions and the majority of companies do not employ draftsmen. An overwhelming number of company operators have a low level of appreciation of the importance of having designers within their own companies. Even though it may not apply in the case of product plans, there are many companies which cannot adequately draw plans for molds and dies, and more than half the companies rely on plans supplied by their customers. There are many cases where design and drafting are confused. The design of molds and dies is a

comprehensive engineering technology for metal processing, molding and mass production which is based on dynamics, material engineering, mechanical science and measurement engineering. There are, however, few companies which understand this. There were more than a few operators who were under the misunderstanding that by introducing CAM/CAM they would be able to undertake design straight away.

[2] Regardless of whether they are full-time or part-time it is difficult to distinguish which employees are in charge of production management.

[3] Though the percent of companies who have quality control supervisors is increasing, basically, manufacturers have not yet graduated from the stage of guaranteeing rudimentary quality by carrying out inspections at the final stage of production.

[4] In order to become a competent mold and die worker in Japan, it is said that one must graduate from an industrial high school and then accumulate ten years of experience. However, the majority of mold and die workers in Thailand have less than five years' experience and for most of them their highest educational qualification is graduation from middle school. As a result, it is thought that they do not acquire basic engineering knowledge.

(Countermeasures) Retraining and Fostering Technical Experts and Skilled Workers

As well as being a labor-intensive industry the modern mold and die industry is a technology-intensive industry with a high ratio of machinery and equipment. If the level of the Thai mold and die industry is to be raised, it is necessary to foster and carry out the continual training and education of technicians who are backed up by engineering knowledge. Possible measures to achieve this are listed below:

- Increase engineering courses at universities
- Increase mold and die courses at industrial high schools and vocational training centers
- Expand the function of occupational training, re-educate skilled workers, and foster training instructors
- A certification system for workers who have undergone training
- Increase technical standards and control standards
- Hold seminars and short courses on the various forms of technology and technical management
- Joint research and development between training facilities and educational facilities such as universities and junior colleges (there is a considerable lack of horizontal ties in Thailand)

- Guidance given by technical consultants dispatched to factories (because many of the medium and small manufacturers are suspicious of the government and also lack engineering knowledge, on the job training and on the job consultancy would prove effective)
- Invite experts and consultants
- Translation of materials for training and technical education and manuals and ensuring that they are widely used by medium and small-scale companies.

(4) (Problem) Old Machinery and Equipment and Insufficient Understanding of Machinery and Equipment

[1] Lathes and shapers are mainly used as the means for the machining molds and dies and most of them are old and also second hand.

[2] Although an increasing number of milling machines are being used and they have become the main piece of processing equipment, many of them are old and the small radius of the spindle makes them unsuited for heavy machining. Also, most of them are operated manually. Although some have profile functions, there are very few which have the digital read-out or NC functions which are required in the next processing stage.

[3] Despite the sharp increase in the number of companies using EDMs whereby it has become quite fashionable to use them, the overall ratio is low. The use of W/C EDMs could be said to be in the preliminary stage. There are also some who are under the impression that if they have an EDM they are able to undertake every sort of complicated process.

[4] A mixture of old and new machinery is to be found in any one factory, and because processing precision is determined by the level of the old machinery, full use is not made of the capacity of new machinery.

[5] Surface plates, fundamental in the machining process which affects measuring standards, are hardly to be found.

[6] There is little appreciation of the precision of molds and dies, and as a result the importance of measuring instruments which are vital for improving quality is not understood. There is also little interest shown in investment.

[7] A fair amount of mistakes are made in surface treatment (heat treatment and plating, etc) because the companies which undertake such processes have an insufficient understanding of the intentions of mold and die manufacturers and the materials used for molds and dies.

(Countermeasures) Replacement of old machinery and improved understanding of machinery and equipment

Though there are various types of molds and dies, all of which have different requirements in regard to quality, the basic trend is towards high quality. In order to manufacture molds and dies which are high in quality it is essential to understand machinery, and in particular, the precision of machinery.

- Increasing technical education and training (the same applies to this as to the re-education and fostering of technicians and skilled workers in the previous section);
- The promotion of modern equipment through the supply of long-term low interest loans;
- Preferential measures for taxes and duties affecting the purchase of processing machinery and inspection and trial machinery and equipment;
- The joint purchase and joint use of expensive processing machinery, and inspection and trial machinery and equipment at an industry level, and also the establishment of joint factories.

(Results of the Survey Conducted in Thailand)

For the first survey, interviews and on-the-spot surveys were carried out with 42 mold and die and related factories, 7 groups and educational facilities, and 5 government offices, making a total of 54 different places. Then second survey involved the same interviews and on-the-spot surveys covering 6 mold and die and related factories, 1 educational facility and 5 government offices, making a total of 12 places.

The mold and die factories surveyed as part of the on-the-spot surveys can be classified into 4 broad categories. The first group consists of the mold and die factories of large companies and the in-house production divisions of foreign capital companies, the second consists of factories which have close ties with large companies or foreign capital companies which use molds and dies, the third consists of factories belonging to Thai companies which produce molds and dies ranging in quality from medium grade to high grade by using engineering design and production, and the fourth consists of local companies which manufacture molds and dies through a combination of experience and sense and which produce copied products. Representative examples from these 4 groups are shown below:

(1) First Group

[1] National Thai Co., Ltd.

The company is an affiliate of Japanese Matsushita Electric. Operations commenced in 1960 and annual turnover is 15 million bahts. The company employs 1,500 staff, 12 of them are Japanese.

The company manufactures color televisions, dry batteries, storage batteries for automobiles, car stereos, fans, etc. A total of 28 engineers and workers are engaged in the mold and die factory. The machinery and equipment used are 6 milling machines (one of which is a profile), 2 EDMs, 1 wire cut EDM, 1 setting machine and 1 lathe. The basic plans for the products are made in Japan and on the basis of these, plans are made for molds and dies in Thailand which are suited to the situation there. There are plans to introduce CAD/CAM within the next 2 to 3 years. Although the person who conducted the tour through the factory said that the processes from design through to manufacture have finally caught up to the standards achieved in South Korea and Taiwan, the finished molds looked just the same as those in Japan.

[2] Thai Toyota Auto

The company was established in 1962 and 65% of the investment ratio is held by Toyota and the remaining 35% by Thai interests. As of March 1988 the

company employed 1,212 workers (690 of whom are involved in the factory). As for annual sales, 20,905 units were sold in 1986 and the estimate for 1988 is in excess of 30,000 units.

There are 20 workers and engineers involved in the mold and die factory. The machinery and equipment which are used are 1 copy milling machine, 1 vertical milling machine, 1 lathe, 1 shaper, 1 vertical boring machine, and 1 setting machine. Most parts are produced by molding contractors and molds are made for odd shaped molds by using gypsum models which are supplied by Toyota in Japan. Though the manufacture of molds is labor intensive, there are no problems as far as quality is concerned.

(2) Second Group

[1] Sammitr Motor Manufacturing Co., Ltd.

The company was established in 1959. It produces automotive parts and car bodies and has a work force of 1,000. There are 300 engineers and workers who are involved in mold and die production. Out of this number there are 5 engineers (university graduates) and 10 draftsmen. Toyota has undertaken the training of these workers itself. Workers have been with the company for between 2-7 years. Due to recent moves by overseas companies to set up operations in Thailand job hopping has become somewhat of a problem.

The molds that it manufactures are for making panels for automobiles. Production volume is on the C scale - on a scale of the three categories of A (large), B (medium) C (small) - and 24 units are produced per month. The company's main customers are Toyota, Nissan, Honda, Mazda, Daihatsu, Hino, Ford, Citroen and Renault. For finishing the method of using many workers is adopted.

With its elementary engineering books, QC circles, employees and remuneration system the company is rather similar to Japanese companies.

[2] Narong Industry

The company manufactures parts for automobiles and motorcycles. It supplies 80% of its products to Yamaha and the remaining 20% consists of parts supplied to Isuzu and Hino and also plastic containers. A total of 496 workers are employed by the company.

61 employees are involved in mold and die related work, 6 of whom are designers. The machinery and equipment at the repair plant consists of 1 lathe and 2 vertical milling machines, and at the new manufacturing plant 3 lathes, 9 vertical milling machines, 2 copy milling machines, 2 EDMs, 3 shapers, 1 drilling

machine, 1 surface grinder and 1 setting machine. There are mainly vertical milling machines in the mold and die plant, all of which are digital. (This was the only such case encountered in the course of the on-the-spot survey.) There are relatively few edges in the case of injection molding goods. However, the cooling system is not good and there is the problem of the small number of shots. There is plenty of room for improvements to be made in regard to the design and quality control of molds and dies. The company's stance concerning joint ventures with overseas countries was positive.

(3) Third Group

[1] Angstrom Co., Ltd.

Established in 1985 it manufactures precision molds of use in IC parts. The work force consists of an engineering manager and 2 designers-cum-draftsmen (basic design, however, is carried out by the president), and the company's standard practice is to rely on models provided by customers. Inspection is carried out by both the company and its customers. The layout of the processes was thought out by the engineering manager and the president, but in actual fact it is a case of trial and error and advice is often sought from a university professor. There has also been an instance of inviting an engineer from Singapore to provide guidance.

The operator of the company is a graduate of the King Mongkhut Science University and has a basic engineering knowledge of design and manufacture. He also shows a strong interest in intellectual matters. He belongs to the new breed of operators of mold and die manufacturing companies in Thailand.

[2] Micron Max Co., Ltd.

Established in 1984 it has a registered capital of 1.0 million bahts (its assets are currently worth 10.0 million bahts), and in 1987 it recorded an annual turnover of 10.0 million bahts. The company is run by the president who used to work for the National Semiconductor Company and who is also a graduate from the engineering department of Churalongkon University.

The company carries a work force of 64 and the majority of those who work in the manufacturing division are high school graduates. Machinery and equipment consists of 9 grinders, 1 EDM, 4 milling machines, and there is also a Japanese-made tool microscope.

Processing to a direct line precision of ±0.005mm is possible. The company can be expected to develop provided that appropriate guidance is given from outside.

(4) Fourth Group

[1] Saha Kam Chang

The company manufactures molds and dies on the basis of EDM processing. It employs about 10 workers (the number varies daily due to the daily wage system it has adopted). The company is run by one man, the president, who sees to all aspects of operations. No account ledgers are kept. Technical decisions are made on the basis of the president's own experience. Maintenance is not carried out for the processing machines and measuring instruments (cleaning, however, is carried out). The president takes a negative attitude towards training his employees. Most delivery dates are not kept.

The president has absolute confidence in his own experience and is satisfied with the way things are run at the moment. The impression received was that business is quite good. In Thailand today there is a high demand for molds and dies and the company is considering expansion.

[2] Anuphap

Established in 1987 the company is run by one person and employs 12 workers. Though skilled workers are necessary, a negative attitude is taken towards the employment of university graduates because it is believed that they cannot be used constructively. Also, the company's employees are unreliable as they often take days off without permission. The operator is contemplating reducing the scale of his company's operations.

The experience of the president is relied upon for manufacturing methods. Processing is undertaken on the basis of products or product plans and there are no plans for molds. Skill is relied upon for mold and die processing and rather than using high precision machinery. The method of using a number of workers is adopted.

III. TOY INDUSTRY

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1. Analysis of the Present Situation

1-1. Present Policy Measures

In 197 the Board of Investment (BOI) designated the toy industry as an investment promotion industry. In order to qualify as an investment promotion enterprise companies must meet two requirements: 1) they must have a capital investment in excess of 2 million Baht (excludes the cost of acquiring land); and 2) exports must account for more than 50% of total sales. Companies which qualify as investment promotion companies are able to receive privileges aimed at export promotion.

Also , as well as the export promotion policies of the BOI the Tax Department has established a system for refunding the import duties imposed on raw materials, parts and semi-manufactured goods which have been imported for the manufacture of export products. However, among toy manufacturers there are those who would like to see improvements made to specific problems. There include a disparity in the estimated value of imported materials which are used in the production of export goods and the long time it takes to receive a refund for duties which have been paid.

1-2 Industry Structure

1-2-1. The Industry in General

Table III-1 shows that the Department of Customs' Trade Statistics on Thailand classifies exported toys according to 7 commodity codes. Goods which fall under commodity codes 970201(Dolls) and 970301(Other toy's working models) account for the greater part of the total export value of toys. In 1986, 95 percent of total toy export value was from these two commodities It is estimated that most of the goods classified under code 970201 and 970301 are stuffed toys and plastic toys respectively. It is possible to gauge present export trends relating to stuffed toys and plastic toys by looking at trends in the statistics provided for the two codes. (Chart III-1)

There has been a significant increase in the export value of toys since 1982 when toy companies eligible for BOI privileges commenced exports. The growth in the export of plastic toys has been particularly striking. It could be said that the plastic industry has taken off as an export industry as a result of adopting the OEM system. Although stuffed toys have not grown by the same extent to which plastic toys have, the export of stuffed

Table III-1. Trends in Thai Toy Exports by Type

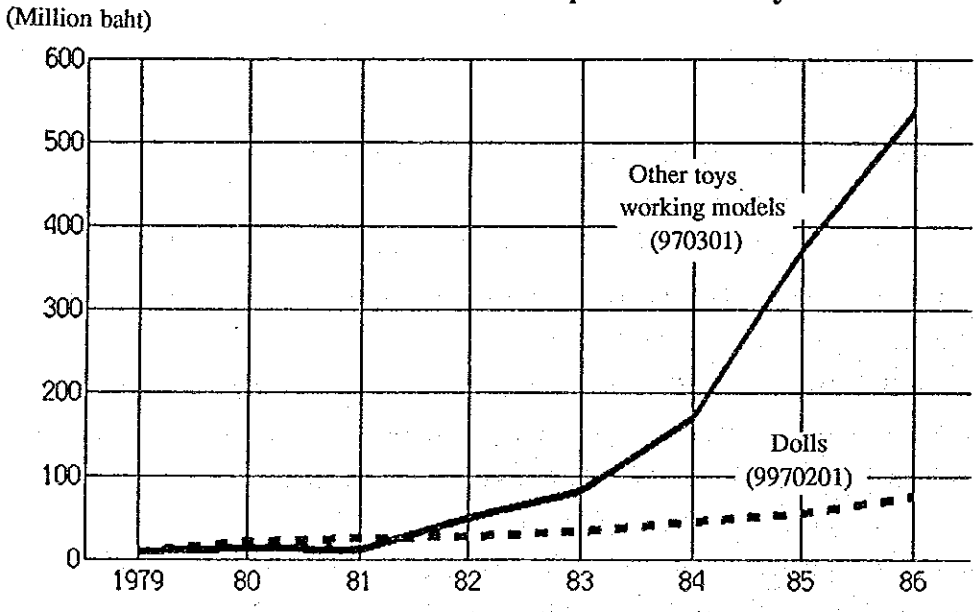
CCCN	970101:	Wheeled toys
	970102:	Dolls' prams & dolls' push chairs
	970109:	Parts & accessories of wheeled toys, dolls' prams & dolls' push chairs
	970201:	Dolls
	970202:	Parts & accessories of dolls
	970301:	Other toys working models
	970302:	Parts & accessories of other toys

(Unit: Million baht)

CCCN	1979	1980	1981	1982	1983	1984	1985	1986
970101	3.0	4.6	2.8	3.6	2.0	2.3	1.1	3.0
970102	0.1	0.3	0.5	0.6	0.2	—	—	1.1
970109	0.2	—	4.5	1.6	1.6	0.1	—	0.2
970201	11.8	23.1	27.5	29.9	34.3	46.2	56.7	77.5
970202	—	—	—	—	—	—	0.2	1.0
970301	11.6	15.9	13.2	50.4	82.8	171.3	372.4	539.8
970302	1.3	1.6	3.9	4.2	3.4	7.2	8.0	27.0
TOTAL	28.0	45.5	52.4	92.3	124.3	227.1	438.4	649.6

Source: Foreign Trade Statistics of Thailand, Department of Customs

Chart III-1. Trends in Exports of Main Toys



Source: Foreign Trade Statistics of Thailand, Department of Customs

toys is steadily increasing. At the present time the stuffed toy industry is in the preparatory stage for taking off as an export industry.

Thailand's toy industry consists of about 200 companies. (As of 1983 131 toy manufacturers were registered with the Ministry of Industry.) At the present time, 44 companies have been certified by the BOI as promotion toy enterprises, and out of this number 15 are engaged in operations (as of March 1988). Most of the other toy manufacturers tend to be cottage industry type small scale businesses.

As far as the Thai toy manufacturers which were visited are concerned, there is little subcontracting in their production activities. As a result, there is a tendency for each manufacturer to undertake the manufacture, processing, and supply of all required parts, including very small parts. Only one of the plastic toy manufacturers, a Japanese company, replied that it was putting effort into using subcontractors. A certain number of the other manufacturers use subcontractors in times of peak production. It seems that this tendency of Thai toy manufacturers only promotes a low level of information exchange on market and technical matters between companies within the toy industry, and this is one reason for the slowness in the formation and development of industry groups.

In 1987 the Thai Toy Center was established to represent the industry as a whole, and as of June 1988, 37 companies have become members of the Center. To a large extent, the Center functions as a place for the management within the industry to meet. It does not have the function of guiding or regulating the industry and neither is it involved in solving the issues which relate to the whole of the industry. However, the center is making efforts to fortify their functions and to register with the Thai government as the organization representing the Thai toy industry.

1-2-2. The Plastic Toy Industry

Manufacturers within the Thai plastic toy industry can be divided into two main groups. One consists of the three large companies: Thai Toy Co, Imperial Thai Toy Co, and Dynamic Toy Co. Companies comprising the other group range from medium and small-sized manufacturers to cottage industry type workshops. At the present time there are one or two middle-sized companies which could possibly become large companies in the future. However, they have not been in business for very long,and it would seem that it will take some time for them to expand. With the arrival of the two Japanese companies, Tomy and Imperial and K.C., on the scene in the first half of 1988 the number of large companies has increased to five, thus making the dichotomy of the plastic toy even more distinct.

Today it would seem that there are no criteria for classifying Thai plastic toy manufacturers . Therefore, for the purpose of this survey, they have been classified as outlined in Table III-2. They have been classified on the basis of the on-the-spot surveys of the plastic toy companies also from an analysis of data on individual companies provided by the Ministry of Industry. The classifications were also based on an overall analysis which included quantitative criteria such as capital, the number of employees, and sales, and also the companies' product standards, production systems, and technical capacity.

Although the large companies are mainly involved with the manufacture of OEM products for overseas orders, they also produce for the domestic market in which they hold the main share. These large companies possess manufacturing equipment which adequately meets overseas orders for OEM products and they produce a large quantity of OEM products, making good use of an abundant labor force.

A large gap in overall capacity exists between these large companies and those which are medium-and small-scale or below, so that the industry has been divided into two extremes. Nevertheless, medium and small scale companies display a keen enthusiasm for exporting, and there are more than a few cases where their interest in product development exceeds that of the large companies. Whereas in terms of operations the large companies accept the present situation, the managers of the medium-sized companies are dissatisfied with their present situation and, one gets the feeling that many of them are searching for a way out of their present situation. Nevertheless, due to the lack of understanding of the toy industry and the lack of information from overseas, it seems that a considerable amount of time and effort is required in order to raise the level of the industry.

Although there are some small companies and workshops which want future expansion, the capability of the companies themselves is insufficient for this and neither do they formulate any plans. Most of these companies continue to be small workshops, and obeying the directions of wholesalers and their principal contractors, they undertake production without any clear planning.

1-2-3. Stuffed Toy Industry

Among stuffed toy manufacturers, there are only a few companies with more than 200 employees which are constantly involved in exporting. While most of the other stuffed toy manufacturers would like to enter the export market, they are unable to break away from their pattern of producing mainly for the domestic market.

It seems that there are no criteria for classifying Thai stuffed toy manufacturers. Therefore, for the purpose of this survey, they have been classified as outlined in Table III-3. They have been classified on the basis of the on-the-spot survey of stuffed toy companies and also from an analysis of individual company data provided by the Ministry of Industry.

Table III-2. Classification of Plastic Toy Manufacturers According to Scale and Characteristics

	Large Companies	Medium Companies	Small Companies
Capital No. of Employees Sales	More than 20 million baht More than 200 More than 50 million baht	5-20 million baht 50-200 10-50 million baht	Less than 5 million baht Less than 50 Less than 10 million baht
Production Systems	Separate manufacturing processes, assembly lines. Labor-intensive system which places emphasis on mass production efficiency rather than maintaining product quality.	Not much separation of manufacturing processes and the flow of many of the assembly lines is incomplete. Assembly processes are divided into parts and there is a heavy reliance on manual labor.	No correlation between manufacturing processes. Large quantities of parts are made and assembly is labor-intensive.
Quality Control	Quality of products is stable, but overall many finished products are quite rough. Inspections carried out to test functions and for breakage.	Finished parts and quality of processing are rough. Unevenness in assembly among production lots. Test mainly functions.	Little attention paid to finishing of mold products. Checks are carried out to test functions and to find breakages, but high rate of substandard goods.
Product Standard	Most products are OEM products for overseas companies. Few have difficult functions. Products for medium range of infant-10 year-old market.	OEM products for overseas are medium to low level. Most are play toys and games for infant-12-13 year-old market.	Most products are cheap and of low standard. Many are play toys such as water pistols.
Companies Studied through On-Site Survey	• Thai Toy • Dynamic Toy • Imperial Thai Toy • Tomy • Bandai and K.C.	• Jumbos Toy • Lerdsin Industrial • Thai Polyproducts • Udompol Trading • Inter Plama	• Thaisincere • Nasenghuat

Note: Companies were evaluated and classified primarily according to overall capacity, but also using the scale of the companies as a yardstick. Therefore, there are some cases where a company's capital, number of employees and sales do not necessarily correspond to the criteria of the classifications used.

Table III-3. Classification of Stuffed Toy Manufacturers According to Scale and Characteristics

	Large Companies	Medium Companies	Small Companies
Capital	More than 5 million baht	500,000-5 million baht	Less than 500,000 baht
No. of Employees	More than 200	25-200	Less than25
Sales	More than 30 million baht	7-30 million baht	Less than 7 million baht
Production Systems	Separation of the manufacturing process and use of assembly lines. Labor intensive, with emphasis on production rather than on maintenance of product quality. Some facilities on a par with those of Japanese firms.	Little separation of the manufacturing process and many incomplete assembly lines. A heavy reliance on manual labor, with machinery used supplementally.	Labor-intensive manufacture with virtually no machinery. Mostly small-lot, regionally-oriented production and subcontracting work.
Quality Control	*Retalively stable product* quality, though some parts have a rough overall finish. Function checks more common than shape tests.	*Rough product finish and* variations in shape, with inspection standards differing by product group. Function checks are most common and are used for orders from advanced nations as well.	*Few funcion checks, with* marked individual differences among production lots. Variations in shape especially notable. For some products developed in-house there are no specifications.
Product Standard	Most orders either from abroad or from leading Thai department stores. Little in-house development of high-standard products. Animals for infants and young girls form the bulk of production.	Mainly low- to medium-range goods developed in-house for infants and young girls, with occasional OEM production for manufacturers in advanced nations. Animals and simple dolls.	Mostly regional souvenir dolls and small, mass-produced mascot dolls for Thai firms.
Companies Visited in the On-Site Survey	• H&B Intertex • First Corporation	• Kase Rawee • Three's • Home Made Country Lady Group	• Sudaporn Tananchal Group • Ban Pooka Hoo 3 • Dolly Hut Factory

Note: Companies were evaluated and classified primarily according to overall capacity, altough the results generally corresponded with corporate scale. Some of the firms classified as "medium-size," therefore, had slightly fewer than the specified number of employees.

1-3. Operations and Management Control

1-3-1. The Industry in General

Due to the present small scale of the Thai domestic toy market and the slow pace at which the domestic market is expanding, there is a limit to the extent to which Thai toy manufacturers can expand their operations aimed at the domestic market. It is because of this that all enterprises, large to medium and small companies, have a strong interest in using exports as a way of expanding their operations.

The reason why they wish to target the export market is the price competitiveness of toys made in Thailand. For manufacturers who perform labor-intensive operations, such as the assembly process of plastic toys and the sewing process for stuffed toys, a cheap labor force is an important element in maintaining a cost advantage. As a consequence, the basic operational strategy of Thai toy manufacturers is to supply low cost products which is achieved mainly through the low cost of labor.

Although the toy industries of Europe, Japan, and the United States have begun to pay attention to the Thai toy manufacturers, there is still little knowledge about or evaluation of the Thai toy industry, by overseas Also, with the exception of a few, Thai toy manufacturers have no means of collecting information from overseas and do not have the capability to move into overseas markets all on their own. As a result, not much is done in the area of product development and finding new customers (this includes the large companies). Although some individual manufacturers are very concerned with product development and with finding new customers and are looking for ways to achieve this, they lack the ability to come up with concrete forward-looking plans. It is because of this that there are many manufacturers which would like governmental organizations backing up their operational activities in the fields of collecting information frim the export toy markets and overseas public relations for their toy products.

One of the business tasks facing labor-intensive industries is, in general, to lighten the burden of fixed costs. Because the toy industry is an industry which experiences significant changes in workload from season, to season a system which allows for the smooth adjustment in manpower to meet the seasonal changes in workload proves indispensable. In Thailand the toy manufacturers manage to cope with the seasonal changes to operations by using cottage-industry type subcontractors only in times of peak production, and by increase or decrease of operation shifts and overtime hours. There was one large scale manufacturer which managed to deal with this by changing the workers' shifts in the group's companies. Because the supply of labor for Thai toy

manufacturers is cheap and easy to come by, they are able to skilfully regulate the seasonal changes to operations.

1-3-2. Plastic Toy Industry

The bulk of the output of Thailand's three large plastic toy manufacturers is exported. Most of those exports are OEM products which are supplied to large European, American, and Japanese toy manufacturers. Even though these three companies are called the three large manufacturers, they are comparable to subcontracting plants of overseas toy companies. There is always the possibility that orders could be placed with manufacturers in a different country which are able to subcontract at a cheaper price and satisfy quality requirements.

At the moment, these three large companies have not restricted their sales to specific toy company groups, but receive orders from a number of toy companies in the United States, Europe, and Japan which are in competition with each other. As orders increase from now on, it will become more difficult to manage plants while maintaining confidentiality between customers which are in competition with each other and to maintain an order of preference for manufacturing and for meeting delivery dates.

Although the medium and small scale companies have been putting energy into exporting over the past several years, the pace at which they are increasing their output appears to be slow in comparison with the three large companies. There are some medium-and small-sized manufacturers which are seeking OEM exports in order to expand their operations as well as to bring stability to their businesses. In order to develop products in-house, it is necessary to carry the cost of making molds and to secure sales channels. It is because this burden is too much for the medium and small companies to bear that they seek customers for which they can manufacture OEM products.

As an indicator for estimating the price competitiveness of the Thai plastic toy industry, companies were interviewed about their cost structure and the percentage of the manufacturing costs in FOB price. The replies which were received as a result are shown in Table III-4 and Table III-5.

1-3-3. Stuffed Toy Industry

Thai stuffed toy manufacturers are trying to expand their exports using their low prices to attract customers. However, it is expected that from now on they will face fierce competition with South Korea, Taiwan, and also China. For example, even though Thai manufacturers hold an advantage over South Korean and Taiwanese manufacturers in the

Table III-4. Cost Structure of Plastic Toys

Item	Company A	Company B
Cost of Materials and Parts etc.	65%	80%
Labor Costs	35% (includes other costs)	10%
Other Expenses	—	10%
TOTAL	100%	100%

Table III-5. Percentage of Manufacturing Cost in FOB Price of Plastic Toys

Plastic Toys	% of Manufacturing Cost
Company A	95%
Company B	80%
Company C	80%
Company D	80%

area of price, Thai manufacturers cannot easily beat China on this point. Also, in the area of quality control, Thai manufacturers are at a disadvantage when competing with their South Korean and Taiwanese counterparts who have had much experience in meeting the quality control standards of the American market.

The manufacturers are largely dependent on the specifications and designs supplied by their customers for stuffed toys for export, so they carry out subcontractor-style production. If they continue to produce only in this way they will probably lose orders to foreign manufacturers who can supply the same products at a cheaper price. At the present time, the level of own specifications and designs of Thai stuffed toy manufacturers is low, and the products have little appeal. This means that if things stay the way they are, long-term business stability will be difficult.

Confidence in Thai toys from overseas is necessary if exports are to expand. For this to happen, PR activities aimed overseas must be carried out by first fostering the domestic market and improving the quality of products on the domestic market. In this regard, however, there are some Thai manufacturers who have the preconceived idea that while Thai consumers would not notice even if they were to make good quality stuffed toys, overseas consumers are able to tell the difference.

Judging from the goods, sales methods, and the reactions of consumers in a shopping center in Bangkok, there is plenty of potential for the domestic stuffed toy market to grow. In order to develop the domestic market, on top of continuing to produce products for children such as dolls and animals as is being done at present, it would be effective to carve out a domestic market for goods which adults would like to have such as stuffed goods and products which give them a change in lifestyle. For Thai toy manufacturers, the development of the domestic market will provide them with a base for production and lead to stable business.

Among the domestically produced stuffed toys on the domestic market there are many which are copies of overseas products or have been based on the concepts of overseas toys. There does not appear to be any evidence that contracts have been made with the foreign manufacturers to cover design. In order for Thailand to earn the trust of overseas manufacturers as a bona fide producer of toys, it is important that companies and the industry show a respect for copyright. Among Thai manufacturers there are some who lose interest in developing products themselves when there are signs that a product which they have gone to a lot of trouble to develop is being copied by another manufacturer. There is the danger that this will cause the Thai stuffed toy industry to fail to develop.

One gets the impression that Thai stuffed toy manufacturers lack the means of maintaining stable sales throughout the course of a year. The reduction of seasonal fluctuations affecting turnover during the year brings stability to business and makes

planning possible. When expanding into the production of related products and business-type goods by using existing plant and equipment, employees and the same materials as, usual are used, and this is an effective means of filling the gap in sales. To cite Japan as an example, during the period from April through to September when sales in stuffed toys decline, there are companies which have achieved good results by producing vinyl dolls and peripheral goods.

The various Thai manufacturers manufacture only stuffed toys and one sees no signs of selling related products under the same brand name. In other words, stuffed toy manufacturers do not seem to be putting effort into cross-business type management as a means of multiplying their sales, which currently are based on single products. As shown in Table III-6 alone, there are more than 100 related types of products which can be produced by using existing plant and equipment.

Among the stuffed toy manufacturers there are very few who regard turnover as something which is made. Instead, because they are used to making goods according to the specifications and designs of their customers, sales are seen as an end product. It seems that this results in a lack of forward-looking business planning, and it also seems that this makes it difficult to make constructive plans for investment in the plant and equipment.

In addition, stuffed toy companies lack any conception of joining together with related industries to create new business. Development is restricted by having no ties with related industries and by carrying out activities only within the toy industry. It would therefore be a good idea to contemplate using a common characteristic to join forces with related industries. This will also makes it possible to conduct effective sales campaigns.

Manufacturers do not have any system for training their sewers, but they have the idea that it is enough to improve server's skills through their daily works. The quality of products produced by labor-intensive industries depends to some extent on the number of skilled workers. Because it is necessary to have as many low wage skilled workers as possible in order to maintain competitiveness it is important to have an efficient method of training workers such as systematic job rotation.

Companies were interviewed about the cost structure of stuffed toys and the product cost as a means of obtaining indicators for estimating the price competitiveness of the Thai stuffed toy industry. The replies received in this process are shown in Table III-7 and Table III-8.

Table III-6. Examples of Products Fabric Toy Manufacturers Could Produce

Product group	Product items
Kitchen goods:	Table mat, table center, table cloth, table napkin, lunch cloth, lunch box case, canteen holder, kitchen cloth, hiking bag, plastic cup bag, apron, kitchen tissue box case, kitchen mittens, coaster, hand towels, etc.
Bath and toiletry goods:	Tissue paper case, wshing soap bag, toiletry case, emergency medicine case, sanitary napkin case, travel case, perfume set case, sewing set case, shoechine kit case, slippers, toilet slipper, comb case, hand mirror case, pass case, towel, bath towel, etc.
Personal goods and portable goods:	Pass case, shoe bags, paauches, clutch bags, wallet, surfer wallet, home shoes, handy case, purse, drawstring purse, small article case, ponytail holder, sun cap, school bag, pochette, coin purse, mascot coin purse, boston bag, rolly boston bag, triangular bag, mothers bag, tote bag, second bag, handy bag, bucket bag, briefcase, novel;ty candy bag, shoulder bag, air-bag case, mascot pochette, ruck sack, knap-sack, back-pack, lesson bag, nivyl bag, watch belt, hair accessory, waist pouch, handkerchief, key holder, broach, emblem, etc.
Interior goods:	Wall pocket, letter-rack, bed cover, lamp-shade, mirror frame, photo-frame, door-knob cap, school cushion, room cushion, mascot cushion, pot mat, mobiles, telephone cover, curtain, pillow & cover, etc.
Toys and sporting goods:	Name-tag, picnic mat, racket case, golf-set cap, ski case, sports cap, sports mitten, etc.
Stationery goods:	Book cover, pen case, album address book, memo stand, greeting card mascot, bookmarks, etc.
Apparel and small apparel goods:	T-shirts, trainer, ear warmer, *hanten*, vest, *noren*, fashion cap, etc.
Other goods:	Vinyl products of the above for summer etc.

Table III-7. Cost Composition of Fabric Toys

	Company A	Company B
Materials	40 %	50 %
Personnel	40 %	40 %
Other expenses	—	10 %
TOTAL	100 %	100 %

Table III-8. Product Price of Fabric Toys

Company (No. of employees)	Product price (based on retail price, bahts)	
Company A (about 30)	100 ~ 200	
Company B (about 200)	100 ~ 1,800	(Most popular price 180 bahts)
Company C (about 20)	55 ~ 215	
Company D (about 500)	200	
Company E (about 300)	70 ~ 80	
Company F (about 10)	55 ~ 100	(Most popular price 60 bahts)
Company G (about 10)	40 ~ 80	(Most popular price 60 bahts)
Company H (about 30)	60 ~ 120	

1-4. Major Equipment

1-4-1. Equipment in the Plastic Toy Industry

(1) Molding Equipment

Injection molding machines are important as production equipment for plastic toy manufacturers, and they are to be found in all the Thai manufacturers' plants down to the small workshops. The most common molding machines in Thailand are from Hong Kong and Taiwan, and each manufacturer has new and/or second hand machines. Japanese molding machines are very high performance, but their cost proves prohibitive. This is why used machines have mostly been imported. However, starting from about last year, imports of Japanese-made injection molding machines for other industries such as the automobile and electric industries began to rise, and toy manufacturers have also started to introduce them.

Table III-9 shows the actual condition of the various manufacturer's injection molding machines at the time of the on-the-spot survey. The large companies have established systems which allow for mass production and have installed mainly medium-sized molding machines which can be used the most widely for toy parts. Also, among major machinery, Japanese-made machines are very common. Even the medium-scale companies all have medium-size molding machines. However, there are some manufacturers who have mainly small machines and who use them for a range of products.

(2) Processing and Assembly Equipment

Large manufacturers have processing and assembly equipment to suit the various items produced. Thai Toy, which is viewed as the largest company within the industry, has a mass production system with 16 assembly lines and 4 painting lines. Besides having a number of belt conveyor lines, the other large companies also have processing equipment such as ultrasonic welding machines, painting equipment, caulking equipment, and ball lathes. However, to meet future increases in orders and a higher standard for processed items, it will become necessary to make improvements to lines and alter the standard of operations. The situation, though, is such that the capacity for this sort of production technology is extremely low. While medium-sized companies have installed the necessary processing equipment, in many companies this equipment is of a low level. Also, although there are some which have assembly lines, one cannot say that they are used effectively, thus indicating a paucity of technical knowledge. In the small

Table III-9. Injection Molding Machines of Thai Plastic Toy Manufacturers

	Size of Injection Molding Machines			Number	Remarks
	Large	Medium	Small		
Large Companies					
Company A	Δ	ΔΔ		15	Used Outside
Company B	Δ	ΔΔ	Δ	52	
Company C		ΔΔ	Δ	20	Plan further 60
Company D		ΔΔ		20	Total of 56 in group
Medium Companies					
Company E		Δ	ΔΔ	14	
Company F		Δ	ΔΔ	14	
Company G		ΔΔ	Δ	8	Plan to add 20
Company H	Δ	ΔΔ		18	
Small Companies					
Company I			ΔΔ	6	
Company J		Δ	ΔΔ	13	

ΔΔ: major machinery
Δ: equipment machines

companies, after the molding stage, parts are treated badly, and there are no set standards for subsequent processing and assembly operations.

(3) Quality Control Equipment

With the exception of the large companies and some of the medium-sized companies, manufacturers do not have any equipment for testing quality. In many of the medium and small companies inspection is largely carried out visually, and also simple tests for function are carried out. The inspection equipment which is used largely consists of simple equipment such as drop test equipment, torque meters, and measuring machines. In the future it will become necessary to have inspection equipment to test durability, strength, weather resistance, and chemical resistance, and also an inspection facility for undertaking these tests.

(4) Incidental Equipment and Maintenance Control Equipment

Even within the large companies in the Thai plastic toy industry, the situation concerning safety equipment to prevent labor accidents is bad. Also, there are few plants which have cranes for handling heavy molds and other objects. With the exception of the large companies, there are no facilities for the storage of raw materials, parts, and products. Most of the large and medium-sized manufacturers have a minimum level of maintenance control equipment for metal molds used in the plastic molding process. Metal processing machines and equipment for repair and remodelling are to be found in only some plants. Taking the technical level and operational capacity of Thai mold and die manufacturers into account, it would seem that there is a serious problem here.

1-4-2. Equipment in the Stuffed Toy Industry

In the stuffed toy industry there are three main types of equipment. There are sewing machines, cloth cutting machines, and stuffing machines. The situation concerning these machines in the companies which were visited was as follows:

a. Manufacturers located in Bangkok use general industrial sewing machines, among which there are many old-style machines.
b. In Changmai it seemed that many of the manufacturers used home sewing machines.
c. Only a number of companies in Bangkok possessed lock sewing machines which are capable of doing overcasting.
d. Cloth cutting machines were to be found in the relatively large manufacturers which employ more than 200 workers. However, there was

a manufacturer which employed between 20 and 30 workers which used fairly old cutting machines.

e. Only manufacturers which employed more than 200 workers had stuffing machines.

f. Compared with the production method used in Japan for stuffed toy manufacture, there seemed to be many processes where machines were not used and where work was carried out by hand instead.

Overseas buyers consider the manufacturers' capacity for mass production as well as the price and quality revel when they select manufacturers and build a long-term relationship with the manufacturers. When trying to increase exports of mass produced stuffed toys, it will be necessary to promote introduction of machines such as cloth cutting machines, stuffing machines, and industrial high grade sewing machine to raise production efficiency so that a significant volume can be shipped in order to meet the customer's chosen delivery date.