IV. MOULDS AND DIES

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1. Overview of the Industry

1-1 Production

Statistics on moulds and dies can not be obtained in Malaysia, because the statistics themselves are not classified in detail. Production figures of moulds and dies are included in those figures classified under industrial code number [38230] (Manufacture of Metal and Woodworking Machinery).

Concerning the Malaysian mould and die industry, there are 26 manufacturers with 695 employees and an annual output of M$12 million (M$1=¥50), according to the Malaysian Industrial Survey in 1985 compiled by the Department of Statistics, Malaysia.

The Malaysian Industrial Development Authority (MIDA) put the number of mould and die manufacturers at about 60 in its survey conducted in 1987.

Table IV.1-1 Manufacturer, Production and Employee

	Manufacture of metal and woodworking machinery			
Year	No. of firms	Annual output	No. of employee	No. of employee per firm
1983	24	M$ 9.5 million	494	21
1984	24	M$ 9.9 million	493	21
1985	26	M$ 12 million	695	27

Source: Industrial Surveys '83, '84, '85.

As the annual outputs of the smaller mould and die manufacturers are not included in the statistics of the Industrial Survey, the correct total production figures of the Malaysian mould and die industry are not shown.

The total annual outputs of 60 firms are estimated to amount to M$40-50 million in 1987, based on the interviews of the 25 firms surveyed. The output figures of the in-house production of the home electric appliance industry and the automobile industry are not included because they are not available. Outputs are expected to increase 30% in 1988 and 1989 respectively, as demand is rising, owing to the recovery of the Malaysian economy in the latter part of 1987.

1-2 Manufacturers

Malaysian independent mould and die manufacturers serving the needs of other industries on a job order basis are estimated at a total of 60 firms. However, actually more than half of them are manufacturing not only mould and die parts and toolings but also metal stamped parts and plastic parts in addition to moulds and dies.

By district, more than 60% of the mould and die manufacturers are situated in Kuala Lumpur and its environs which is the center of the electric appliances and electronics industry and the automotive industry. The remaining manufacturers are in Penang State. This situation will not change because they are situated near the users of moulds and dies.

Most manufacturers (80% of them) are operated on a small scale basis with an average employment of 20-30 workers. Their paid-up capital is rather small, less than M$1.6 million, and annual sales of the smaller manufacturers vary from M$8.36 million to M$0.1 million.

Table IV.1-2 Location of Manufactures by District

Disctrict	No. of firms
Kuala Lumpur and its environs	37
Penang and its environs	19
Ipoh and its environs	4

Source: MIDA

1-3 Main industries supplied

Supply to the electronic and electric industries

Mould and die manufacturers which supply the electric and electronic industries have developed as a response to requests from export-oriented semiconductor plants which are located in the Free Trade Zones.

At present there are 22 firms which mainly produce moulds and dies for IC production, manufacture mould and die parts and undertake mould and die repairs. With the exception of 3 rather large firms, they each have less than 20 employees and their annual turnover is in the region of M$40,000 to M$50,000.

Locally produced moulds and dies supplied to the electric and electronic industries are worth between M$20 million to M$30 million per annum. This constitutes 20% of the total supply to the electronic industries which is worth M$150 million.

Supply to the plastic moulding industry

Mould and die firms which work as subcontractors to the plastic moulding industry are mostly small in scale. Their moulds and dies are used for the production of products which are made for the domestic market and they are simple and of relatively low level precision. However, some of them do export products to neighboring countries.

There are 4 types of moulds; namely, the injection mould, blow mould, compression mould, and extrusion mould. These moulds are used in the production of electric goods, home appliances, medical instruments and articles for construction.

There are 21 mould and die manufacturers which are associated with the plastic moulding industry, but there are also quite a few moulding and product manufacturers which undertake their own in-house production.

Firms which specialize in moulds and dies are small in size and have work forces of between 10 and 20 employees. Local mould and die manufacturers supply between 20 and 25% of the needs of the plastic moulding industry which is worth a total of M$50 million per annum.

According to the Federation of Malaysian Foundries and Engineering Industry Association (FOMFEIA), mould and die production in Kuala Lumpur and its environs was worth a total of M$14 million in 1985.

Supply to the metal working industry

Moulds and dies required by the metal working industry are those which are used for the production of stamped parts such as parts for electric machinery and appliances, automobiles, and home appliances. Although the manufacturers of press dies for goods such as these are still not very advanced, the progress made by local manufacturers in producing automobile parts, electronic parts for industrial use, and good quality home appliances has led to the growth of the press die industry.

In addition to the in-house production carried out by aluminum extrusion plants and press parts manufacturers today, there are 11 specialized manufacturers. While there are no accurate figures for the output of this industry, the industry source has put the figure at somewhere less than M$10 million per annum.

As for die casting, although there are presently 11 die cast manufacturers which produce automobile parts, cable terminal boxes, and parts for fans, etc., imports are relied upon for all of the dies which are used for such die casting.

Supply to the rubber processing industry

With the exception of moulds for tyres, there are few manufacturers of moulds for rubber so there is a heavy reliance on imports.for these.

1-4 Summary of Manufacturers Surveyed

25 mould and die manufactures, including one in-house manufacturer, have been surveyed and can be summarized as follows:

1-4-1 First Group

The first group is composed of two foreign affiliated firms: Micro Machining Sdn. Bhd. of National Semiconductor Corp. of America and Mattel Tools Sdn. Bhd. of Mattel Inc. (a toy maker) of America.

Micro Machining is the biggest mould and die manufacturer in Southeast Asia with 190 employees and M$8.38 million in annual sales. It has the capacity to produce dies for lead frames of micron order and is equipped with first class CNC EDM and CNC Machining Centres.

Mattel Tools is the manufacturer of plastic moulds for toys. They have 100 employees and M$4 million in annual sales. They also have the capacity to produce plastic moulds to micron precision, although with less accuracy for plastic toys.

Both manufacturers supply all of their products to related companies in Malaysia and overseas. Mattel has closed its factories in Taiwan and the Philippines and is planning to centralize its facilities in the Penang factory.

Both companies have excellent technical levels, good OJT training systems, and well organized pay scale systems clearly classified by job grades. They are superior to other firms in respect to company size and technology.

The Malaysian Government is expecting to invite more of this kind of establishment and technical transfer.

1-4-2 Second Group

The second group is composed of two Japanese joint venture companies, Matsushita Electric Co. (Malaysia) Bhd. and Topla Engineering (Malaysia) Sdn. Bhd.

Matsushita Electric, the manufacturer of home electric appliances in Shah Alam, a suburb of Kuala Lumpur, has started in-house production of moulds and dies and has imported other moulds and dies from Japan and Singapore which could not be supplied by in-house production.

From January of 1987, it has started to supply products to Matsushita group factories in Malaysia and Singapore for the purpose of fully utilizing its facilities and is

now selling 40% of its moulds and dies to them. It has 40 employees supervised by one Japanese senior engineer with M$1.4 million in annual sales.

Topla Engineering was established in Ipoh City, midway between Kuala Lumpur and Penang, aiming at both markets. Since its establishment five years ago, it is expanding its business step by step as one of the best independent mould and die manufacturers.

One Japanese senior engineer supervises the local staff for OJT training and technical transfer by introducing a Japanese production system. The firm supplies its products mainly to Japanese affiliated companies in Malaysia. As it has had many orders for hardened moulds and dies from this year, it has invested in new machinery and equipment whose depreciation is rather heavy.

The technical level of both companies is excellent, having precision to the micron order, as well as being able to meet the requirements of Japanese users. They have firm management policies to pursue localization by transferring technology and fostering local staff. They are good examples of future joint ventures and technical tie-ups.

1-4-3 Third Group

The third group is composed of well-organized medium-sized local firms such as ENG Hardware Engineering Sdn. Bhd. in Penang. This company has more than 100 employees and M$4.3 million in annual sales and produces high-precision moulds and dies and jigs with the most advanced CNC machinery and equipment. It even produces progressive dies of its own design as well as tie bar cut moulds and dies.

Loh Kim Teow Engineering, another firm in Penang, has 100 employees and M$4 million in annual sales. It also has a high level of technology.

Hup Lee Engineering Works, a plastic mould manufacturer in Kuala Lumpur, is also in this group, having about 50 employees. For a medium scale company, it has a high level of technology.

Another company with some high level technology is Sun Tong Seng Mould-Tech Sdn. Bhd. in Bangi, a southern suburb of Kuala Lumpur, with 30 employees. Its annual sales were M$1.2 million and are expected to increase 30% in 1988.

As they are lacking in skilled workers, its handling of machinery is rather rough. Their level would be improved if it were ready to accept experts' advice and try harder.

1-4-4 Fourth Group

The fourth group is composed of nearly 50 small-sized firms having less than 30 employees (mostly 10 to 20 employees). They have the technical level to produce moulds and dies with precision to 0.1mm.

Spurred by the recent brisk demand for moulds and dies, those firms plan to purchase the most advanced sophisticated machinery and equipment. Actually, they were going to install EDM and Machining Centres. It is possible to raise accuracy by introducing high-precision machinery and equipment. However, they are only part way toward getting precise accuracy because they neglect the basic skills of metal cutting, grinding, and polishing and also they are lacking in skilled workers including design engineers. Some of them are still using older machinery and equipment because they have limited assets to pledge as collateral for bank loans.

The Malaysian Government firmly recognizes that the mould and die industry is a most basic supporting industry and a very important one. It has already designated the mould and die industry as a high priority item in the Industrial Master Plan (IMP) which is the basis of Malaysian industrial policy, and has already reviewed the plan to start developing the industry. One of the biggest themes for fostering and developing the mould and die industry should be to raise its technical level by fostering skilled and ordinary workers in the fourth group of firms.

1-5 Malaysian Import Trend

Malaysia imports 80% of plastic moulds and dies heavier than 3-4 tons from Japan, Taiwan and Singapore. The work size of the rest of the machine tools of almost all mould and die manufacturers is less than 1,000 mm x1,000 mm with some exceptions.

Also, it has to import moulds and dies with accuracy of a micron order. It can produce and supply locally moulds and dies for parts of home electric appliances and automotive parts in addition to those for simple sundry goods (tolerance level 0.1mm). On average, the users of mould and dies import more than 70% of their total requirements.

Almost all metal materials are imported from overseas. As prices of imported metal materials are rather expensive, the material ratio of production cost is rather high. Local supply of metal materials is not likely since consumption of such materials is very low. So, these materials continue to be imported for the time being. It would be better to give some incentives to manufacturers by supplying imported materials at low cost.

Table IV.1-3 Import of Moduls and Dies Excluding Ingot Moulds

(Unit: M$ 1,000)

Countries	1985	1986	1987
Australia	2,069	714	823
West Germany	2,925	4,903	6,281
Hong Kong	5,620	9,270	8,693
Italy	3,295	970	1,435
Japan	22,177	28,665	37,960
Republic of Korea	1,666	863	3,288
Singapore	9,573	10,660	12,095
Taiwan	9,782	10,787	13,337
United Kingdom	2,683	1,319	2,872
U.S.A	3,730	5,988	6,800
Others	6,543	5,845	11.099
Total	69,961	79985	104,683

Source: Malaysian Annual Statistics of External Trade

Imports of moulds and dies (No. 749-910-00) are set out in Table IV. 1-3.

It is to be noted that these import values do not include those supplied to the Free Trade Zone (FTZ) and the Licensed Manufacturing Warehouses (LMW) in the country or the values of moulds and dies which are imported together with other machinery or as machinery parts recorded in different import codes. Accordingly, the actual total imports are higher than values shown in the table, but actual values are not available.

In terms of value, one-third of the imports are from Japan, but those from NIES, especially Hong Kong in addition to Taiwan and Singapore, are increasing. It is expected that imports from NIES will increase in the future owing to the strong yen.

1-6 Malaysian Export Trend

It is recognized in Malaysia that supplies to the Free Trade Zone (FTZ) mean exports. Accordingly, the values of exports from the mould and die industry are very large in this area. Some firms are said to export more than 80% of their total products to the Free Trade Zone (FTZ). On average, those ratios are 40-50%.

Table IV.1-4 Exports of Moulds and Dies Excluding Ingot Moulds

(Unit: M$ 1,000)

Countries	1985	1986	1987
Hong Kong	637	378	821
Indonesia	453	499	347
Japan	1,155	1,051	1,279
Singapore	5,760	4,973	13,950
Thailand	1,866	11,956	3,495
U.S.A	505	349	102
Others	879	1,467	5,496
Total	11,255	10,674	25,489

Source: Malaysian Annual Statistics of External Trade

Exports of moulds and dies (No.749-910-000) excluding exports to the Free Trade Zone (FTZ) are set out in Table IV. 1-4. Total export values increased 2.5 times in 1987 because of a sharp increase in exports to Singapore.

Singapore is the largest buyer of Malaysian moulds and dies, and next is Thailand. In both cases they purchase simple ones. Several companies we interviewed mentioned that they export to Indonesia.

Japan is the future market. For instance, the technical level of Malaysian plastic moulds have advanced to some extent (to the Japanese level of 10 years ago). Some Japanese manufacturers could import some unfinished items and finish them in Japan. Further, it is expected that mould and die exports will become main stream as the overseas investment of Japanese firms is increasing drastically, including that in the mould and die industry, owing to the strong yen.

2. Existing Status of Manufacturing Establishment

2-1 Production Process

2-1-1 Designing Process

With some exceptions, mould and die parts design drawings are not prepared in medium and smaller manufacturers belonging to the fourth group. In most cases, product sample drawings are supplied by their customers, but many of them are making moulds and dies only by production samples without even their own drawings.

It is a serious problem to start machining without the drawings. As even simple moulds and dies are one assemblage of metal components and parts, the total accuracy of the moulds and dies depends upon the accuracy of each component and part. In many cases, the accumulated knowledge of experienced engineers (mostly the owners in the case of smaller manufacturers) are respected and their oral instructions are conveyed to machinists to make the moulds and dies. Without their instructions, there would be some trouble on the production line. A more serious matter is that without design drawings the past accumulated technologies and experience are not collected systematically.

The fact that nothing can be done without experienced engineers is a grave matter. If those experienced engineers who are not the owners were to quit , the firms would be on the verge of bankruptcy.

The owners should be expected to make experienced engineers hand over at least hand-written design drawings to machinists for on-the-job training.

In some firms, the correct instructions are conveyed to machinists by hand-written three dimensional drawings, and there are also well organized firms in which machining operations are not allowed until after machinists read and understand the design drawings. There are very few firms that have good on-the-job training systems to foster design engineers from the start.

In designing, basically, a very wide knowledge of production processes, products, accuracy requirements, and the capabilities of each machine installed in each factory is necessary. For instance, the firms need sophisticated machine tools capable of making precise components and parts if they have excellent drawings. And they must know the capabilities of their metalworking technology, otherwise their intentions will not be realized. Finally, placing importance on designing will determine the direction of the firm's future standardization. Theoretically, good designing is expected to generate all information such as production lead-time, delivery time, and cost of the product at the

time that a drawing is completed, but this level has not yet been accomplished even in Japan. The expectation for good design is partly achieved by the establishment of CAD (computer aided design) systems, but actually complete software for CAD systems is not ready even in Japan.

As mentioned before in relation to designing, accumulated experience is a decisive point because wide knowledge of every production process is required. In Malaysia, the average experience is 3-5 years depending on the firm. In fact, Malaysian design engineers with 10 years experience have a level of training which equals only 5 years of experience in Japanese technical levels.

Without design drawings, pre-checking on how to improve and add new ideas, or to reduce costs, or to accomplish easier assembling in mould and die making is found to be inadequate and incomplete. More technology transfer and information should be constantly provided to the industry from the outside.

Because of the lack of experience, most of the firms depend heavily on drawings supplied by their customers. It is supposed that only 10% of the firms have their own design and component drawings, and the firms with hand-written drawings make up 20% of all firms. The remaining firms make moulds and dies from experience, with information other than drawings.

During the survey, almost all owners mentioned the lack of experienced design engineers. All of them recognized the importance of designing and said fostering or quickly employing experienced design engineers is vital for the future development of their firms. To supply more design engineers to alleviate increasing demand is another important requirement. Generally speaking, one design engineer should be assigned to 7 to 8 workers, while ideally one design engineer should be assigned to 4 to 5 workers. Introducing a CAD system is one alternative way to resolve the problem of design engineers. But it becomes meaningless if basic preparations and standardization have not been firmly established.

The more sophisticated the moulds and dies become, the more important designing will become. Subsequently, the cost of designing would also come to occupy a large part in the total cost of production. Under the current situation in which the number of orders from their customers is increasing rapidly, how quickly and accurately design engineers can prepare drawings is one of the most important factors for the development of the industry.

Designing is fundamentally concerned with the level of education. Basic skills, such as reading and writing, drawing, calculations, accurate machining, drawing

methods, and designing methods are basically determined by the level of education offered by individual educational and training institutions.

In this respect, expansion of the mould and die training courses and establishment of mould and die classes at ITI, SIRIM MIDEC, and Polytechnics (Industrial high school) are urgently needed.

One problem arising here is that the graduates from these kinds of educational and training institutions do not have practical skills which are directly applicable in real work. So, it is suggested that further training is necessary to meet the different needs at each individual firm.

If each firm were to provide this basic education, it would be a heavy burden for them in terms of time and money. It would be much easier and more time efficient to educate and train newcomers entering the mould and die industry after they have completed the basic education.

Generally, it would take more time, at least 4-5 years longer, to foster design engineers than to foster ordinary skilled machinists. So, all necessary measures should be immediately taken.

Shown below for reference is a graphic ratio of attainments in Malaysian mould and die designing compared with Japanese standard designing levels in medium- and small-scale industries in Japan as 100%.

*** Graphic chart of designing ***

	Attainment Ratio 0% 50% 100%	
Product drawings	——————→	(60%)
Mould and die drawings	——→	(20~30%)
Mould and die components drawings	——→	(10~20%)
Hand-written drawings	——————→	(30~40%)
Skill level	——————→	(40~50%)
No. of designers	——→	(10~20%)

2-1-2 Machining Process

Analysis of the machining process was conducted from two different points of view: Hardware (machines and facilities) and software (skill of workers, metalworking

methods). It is rather difficult to pinpoint an average level for hardware because the level of hardware varies greatly from firm to firm. It was, however, made clear that all firms are equipped with at least the lowest line of machine facilities. These are the ordinary machine tools necessary to make moulds and dies such as lathes, milling machines, jig milling machines, shapers, drilling machines, radial drilling machines, surface grinding machines, engraving machine sinkers and EDMs (Electric Discharge Machine), etc. They are rather old and unreliable because they are not well maintained.

Many Taiwanese machine tools have been introduced into Malaysia. More than half of the machine tools of the firms surveyed are Taiwanese. The main reason is their cheap price, half that of Japanese machine tools, plus the fact that it is also easy to depreciate them. In the case of general purpose machine tools, extreme accuracy is not required if some level of skill is attained.

Many American jig milling machines are installed in the firms together with Taiwanese machines. Well organized firms are equipped with first class overseas machinery and equipment which is new and well maintained. But, most firms operate machines very roughly and over their capacity.

Operation ratios (total machine operating hours + total working hours) were said to be 80% at the interviews with firms surveyed, but actually are thought to be 30-60%, although there is no actual data. According to Japanese data, ratios are 20-50% in the case of general purpose machine tools and 70-80% in the case of NC machine tools.

On the other hand, both well organized and medium-size firms are equipped with CNC and NC machine tools such as CNC Machining Centres, CNC EDMs and CNC Wire-Cut EDMs, etc. Most of them are of Japanese and European make, but machine tools such as those made by joint-venture firms between Japan and Singapore have also been imported because of their cheap prices. These high-priced machine tools are operated efficiently and correctly even on two or three shifts. As the impetus for equipment investment is increasing owing to Malaysian economic recovery, most firms are ordering or ready to order the newly advanced machinery and equipment in the near future. Modernization of factories through installation of advanced machines would contribute to improved accuracy as well as machining speed.

From the standpoint of software, its development is still very slow, stemming from the lack of experienced workers in the field compared to the excellent facilities. This was proven from the fact that even firms equipped with the latest machining facilities did not pay so much attention to the basic machining skills. Some software problems were observed as follows.

a) How to shape the edges of drills, grind the degree of edges and center drill centers. Drills more than 8mm in diameter should be ground by drill-grinders.
b) In many cases, the grinding wheels seemed to be so hard that the surface of drill edges might be rough.
c) Inadequate theory between cutting speeds and cutting revolutions.
d) Wrong sequences of cutting works for six surfaces.
e) Inadequate degree of cutting tools, bites for lathes, and shapers.
f) How to use End Mills and Disposable Cutters when using milling machines.
g) How to use Cemented Carbide tips, and grind them with diamond wheels.
h) What is the cutting limit capacity for the machines? Problems of overload often occur.
i) How to use surface grinders by wet or dry type. The balance and dressing of grinding-wheels are wrong.
j) How to set the Electrode with the aid of one-touch accessories for EDMs to reduce setting times.
k) The reason why work tanks are filled with oil (danger of fire).
l) The maintenance systems of machines, annual precision checks.
m) How to use levelling-blocks under machines to keep them accurate.
n) How to use measuring equipment, for example, calipers, dial gauges, squares, height gauges, etc. (in particular, height gauges with sight-allowances).
o) Management of high-accuracy accessories for machines which are seldom used.

The above mentioned problems are commonly observed in most firms. These problems could be solved by in-house-training, especially on-the-job training, but they should really be taught in the basic educational institutions. Another big problem found though the interviews is the lack of skilled workers. Human factors are vital for making moulds and dies and future development depends solely on workers' higher level of skill. One firm that can not secure skilled workers plans to close its mould and die division.

Taking into consideration the fact that workers in Malaysia are diligent and are eager to acquire advanced skills through work experience, it is supposed that a worker can obtain a certain level of skill in a relatively short period, such as 2 to 4 years, through practical advice and systematic educational and training programmes.

Cases of domestic firms with systematic training programmes have also been observed, and these have achieved substantial results. Further, workers employed by

foreign-affiliated firms or Japanese joint venture firms have acquired a high level of skill through in-house job training, especially OJT.

A graphic representation of the ratio of local firms' metalworking productivity attainments is shown below. Medium and smaller firms are selected, excluding first class firms from the sample, and they are compared with Japanese counterparts of the same size.

*** Graphic chart of metalworking ***

	Attainment Ratio 0% 50% 100%	
Machine operation hours	——————→	(30～50%)
NC machine operation hours	——————→	(40～60%)
Skill level	——————→	(30～40%)
Level of metalworking	——————→	(20～50%)
Level of measuring	——————→	(20～30%)

2-1-3 Assembling Process

The assembling process is further subdivided into two processes. One is to assemble pieces into one mould or die; the other is to adjust the assembled moulds or dies through trial use.

The first process, assembling pieces into one mould or die, mainly depends on how accurately each piece is machined, and if each piece is accurate enough, the assembly does not take a long time. On the other hand, each piece has its own tolerance of accuracy. So, if each piece is inaccurate, tolerances accumulate when they are assembled, and this immediately affects product accuracy. Accumulated tolerances are barely on the order of 0.1mm in most cases judging from the poor accuracy of finished components.

Many firms do not have any systematic troubleshooting measures to deal with inaccuracy troubles. Workers in the field just judge for themselves if inferior components should be modified or completely remade without considering the overall situation.

Any worker can easily judge how to do orderly assembly and where more accuracy is needed if he has the daily training which enables him to see which parts of

moulds and dies are more important in terms of accuracy. In doing so, modification can be quite easy in the case of re-assembling. Usually, Malaysian workers are not trained to reduce problems and think that the assembling process means just assembling the components and parts without any modifications or adjustments. Consequently, they put unmodified or unadjusted moulds and dies on trial.

The next process is the adjustment of the assembled moulds and dies. This final process is a must and should not be neglected, particularly in the case of high precision moulds and dies.

In the case of press moulds and dies, inferior parts should be modified and adjusted by sight checking or using measuring instruments. After a trial of the assembled moulds and dies, adjusting the progressive die completely to produce satisfactory final products takes a great deal of time and labour. But actually these accumulated experiences become the know-how of the firm.

The situation is the same in moulds and dies for plastic forming. Usually, second and third trials are necessary for adjustment. Even the most advanced plastic mould manufacturers in Japan need an average trial of 1.8 times. But, if they require more than a third trial, they would lose money in Japan.

In Malaysia, adjustment of assembled moulds and dies is virtually neglected except for a few cases where critical defects in products are found. In addition to the unavailability of trial machines, more than half of Malaysian mould and die manufacturers do not have a system of feedback from their customers for adjustment. This lack of a feedback system creates a big technical problem for Malaysian manufacturers preventing improved levels of technology or reductions in cost.

At present, the situation in Malaysia is such that the quality of products can not be guaranteed because they are fully occupied with ever increasing new demands. A few firms have trial machines and make the necessary adjustments (trial-adjustment-delivery), but that number is very limited. Since adjustment is inevitable for every instance of mould and die production, mould and die manufacturers must realize that establishment of an adjustment system is the key area for the accumulation of their production know-how and for their future development.

Based on the same criteria with the previous section, the technological level of Malaysian manufacturers in the assembling process is illustrated below.

*** Graphic chart of the technological level in assembling process ***

	Attainment Ratio 0% → 50% → 100%	
Components completion	⟶	(40~50%)
Assembling skill	⟶	(30~40%)
Worker's skill	⟶	(30~50%)
Troubleshooting measures	⟶	(20~30%)
Adjustment trial	⟶	(10~30%)

2-2 Technical Level

2-2-1 Moulds and Dies for Plastic Forming

The technology level in this field is relatively high, with the accuracy tolerance achieved by general purpose machine tools such as laths or milling machines falling within 0.01mm. Some firms have already been achieved even micron order accuracy of tooling, which subsequently could achieve overall product tolerance within 0.1 to 0.5mm and 0.05 mm in sundry products and in precise electric components,respectively.

On the other hand, the average accuracy level of measurements is not high enough. The maintenance of vernier calipers and micrometers is somewhat loose, and consequently decreases the reliability of measurement at the factory site. Almost all firms have vernier calipers and micrometers, but some firms do not use very often high precision measuring instruments by keeping them inside of the office rooms.

In general, Malaysian plastic mould and die manufacturers are judged to have enough capability to produce moulds and dies for home electric appliances although their levels vary from firm to firm and from products to products.

In the cutting process, the basic principles which have to be observed in the process are not strictly observed. Even advanced level of firms do not process materials based on cutting theory and advanced techniques such as deep cutting method.

As for hardwares, highly advanced machines such as CNC machining centre, CNC EDM and CNC wirecut EDM are already installed in some firms. With these modernized machines, remarkable progress has been made both in operation shortening hours and in increasing accuracy of micron order. Because as the price of these automation machines are very expensive (average 20 to 60 million yen/machine) the percentage share of these modernized machines to the total equipment is very low at 5 to 10%. And a considerable portion of the work are conducted using general purpose machine tools with labour intensive methods. The percentage share of labour intensive works are 100 % in ordinary local firms and more than 60% even in advanced firms.

From the nature of the products, three dimensional processing work is most suited for making moulds and dies. But this is not yet generally conducted in Malaysia and even two dimensional processing work is rarely conducted. As a result, it is said that Malaysian manufacturers could supply moulds and dies for imprecise ordinary electric and electronics parts and for home sundry goods manufacturers, but it is difficult for them

to supply for small and precise parts (for electronics, cameras and VTR etc.) or for engineering plastics manufacturers.
Neither they can supply moulds for plastic products of thermoseting resin.

When aiming at total assembling accuracy, it is impossible to modify the unbalances in the size of each cavity and that means less precise measurements. And also, the accuracy in parting lines in the moulds and dies can not be achieved to allow some burr at the parting lines. In Malaysia, inferior moulds and dies which would be rejected by Japanese standards.are accepted.

Plastic moulds should be designed considering the shrinkage which will occur in the products formed, but these considerations are not fully observed because the shrinkage ratio is different depending on the thickness of the parts of each product. And the size and shape of the runners and gates of plastic moulds can be expected to be improved by accumulated experience.

Plastic moulds of hardened materials are very rare in Malaysia. In fact, 90% of the moulds use pre-hardened steel. But one firm is saying that moulds of pre-hardened steel, which were popular until last year have been replaced by hardened moulds in this year. Accordingly the manufacturers have quickly installed the necessary facilities.

This trend has very important implications for the future development of the Malaysian plastic mould industry. As foreign investment and technical tie-ups increases, production of labour intensive products not profitable in Japan and they will be shifted to countries like Malaysia.
Eventually, hardened and durable moulds are supposed to be in great demand and the pre-hardened steel type of moulds will be less in demand because only moulds with high precision and less life spans will be demanded.

If this trend continues in the future, the trend of future equipment investment will be changed. Investment in the forming grinding machines and EDMs for machining hardened materials will be increase instead of investment in machines for machining pre-hardened steel materials. Accordingly, heat treatment has the same important factors as the press die.

As for materials, ASSAB of Sweden supplies them to Malaysian firms and these are recognized as standard materials. The supply of the kinds of materials not in demand are limited. With increasing demands for a wide variety of materials, more kinds of special steel materials will become available at prices as inexpensive as in Japan. The quality of local materials used for die-plates is very inferior.

HASCO of West Germany supplies almost all the standard parts for moulds and dies to Malaysia. Japanese standard parts are few owing to the strong yen.

These special steel materials and standard parts are delivered in a day or in several days at most.

Finally the structure of moulds and dies is weak. In the cheaply made products, mould and die parts such as die plates, guide posts and sliding posts, etc., are rather thin and fragile against external and internal pressures.

It does not cost so much to strengthen the structure, and the total costs are increased only 1% or so, even if the cost for strengthening the structure is increased 10% because the material cost occupy only 15 to 20% of the total cost. Also, strengthening of the structure would lead to stability of the products and fewer claims and also to winning a reputation for superior moulds and dies.

Totally, the technical level in some top class firms is equal to the Japanese level of seven or eight years back but most firms are not so advanced. However, their level should improve because they are planning to introduce the most advanced machinery and equipment in response to brisk demand.

The point is that training and fostering workers is more important than introducing advanced machines, as making moulds and dies is quite labour intensive in Malaysia.

Finally, the cost of making lens caps was compared both in Japan and in Malaysia to compare their technical level. Quotations were requested from the firms belonging to the second, third and fourth group (drawings attached).

The quality of lens caps is rather high, having an accuracy of 0.05mm and fine surface polishing. The purpose of the comparison of lens cap cost is to check whether the technical level is high enough to be able to make products salable in the Japanese market. The firms of the second and third group offered quotations, but the firm in the fourth group could not offer a quotation because they were unable to make the mould (cost comparisons explained in a latter part).

The Malaysian technical level of making plastic moulds could be judged if the firms can make moulds for complicated and precise products such as escutcheons for cassette players as well as the camera lens caps. If they can make such moulds, they have the possibility to penetrate the Japanese market and are thought to be able to "Take Off".

Graphic chart of the technical level of plastic moulds is shown below. The conditions are the same as before.

*** Graphic chart of technical level of plastic moulds and dies ***

	Attainment Ratio 0% 50% 100%	
Mould and die structure	——————→	(40～70%)
Metal work finishing	——————→	(50～60%)
Surface polishing	——————→	(60～80%)
Parting line accuracy	——————→	(30～50%)
Total accuracy	——————→	(40～60%)

2-2-2 Moulds and Dies for Metal Working

Compared to moulds and dies for plastic forming, the technical level of those for metal working is still less developed. This is considered to be due to the fact that not such a high degree of accuracy is required in Malaysian in-house die production and to the domestic low demand for the products. Due to the development of auto industries, the electronic parts industries centering in Penang and home electric industries (TV refrigerators, electric fans, air conditioners), the demand for moulds and dies for metal working is gradually expanding.

In spite of the growing demand, most manufacturers can supply only parts of a component die, and that number of firms is very limited.

The tolerance level that they could satisfy is at most on the order of 0.01mm. There are so many firms whose basic metal working level is very low. However, there are some local manufacturers that can supply precision metal parts of tungsten carbide with accuracy in the micron order for the electronic industry in Penang.

Making moulds and dies for metal working by using hardened materials would need improved processes and more working hours.

It also needs various kinds of know-how about the nature of metal, annealing, hardening, designing, metal working, grinding, assembling and stamping.

So Malaysian mould and dies industries for metal working are said to be at their dawn.

There is a wide gap in the technology level between foreign firms and domestic ones. The firms supplying moulds and dies to the electronic industries are comparatively well developed. But many other firms can not make moulds and dies on their own.

There is not only capital imbalance but also differences in skilled workers and technical information. If these imbalances are left as they are, more skilled workers and more information will gather to the big and developed firms and will not go to the small firms.

In consideration of this, collecting and disseminating technical information and starting training and fostering programmes are urgent needs. When these improvements are made, the problems of job-hopping and workers keeping technical information to themselves will be solved little by little.

The reason that the technical level of moulds and dies for metal working is still less developed is that they do not reach the level of making high precision progressive dies and compound dies for the production of motor cores.

Mould and die manufacturers would have to satisfy the product tolerance requirement of 0.02 to 0.05mm. This is the level which would enable the domestic production of motor cores. In order to achieve the above product accuracy, each part's tolerance would become on the micron-order. For this accuracy achievement, skilled workers who can operate such advanced machines as wire-cut EDM, and forming grinders would be required. By improving the training skilled workers, the technology of making high-precision moulds and dies could be obtained step by step. Japan followed such a process in the past.

Graphic chart of the technical level of moulds and dies for metal working is shown below.

*** Graphic chart of technical level metal working moulds and dies ***

	Attainment Ratio 0%	50%	100%	
Total accuracy	⟶			(20~30%)
Progressive dies	⟶			(10~20%)
Precission parts	⟶			(20~30%)
Non-precision dies	⟶			(50~70%)

2-3 Development of the Mould and Die Industry

For the further development of the mould and die industry, it is required that the development of the electric, electronics and automotive industries raise the demand for moulds and dies. Considering the present circumstances that foreign investments are constantly inflowing and the electronic and electronics industries are substantially expanding, the market for moulds and dies in Malaysia has bright prospects.

2-3-1 Hardware

Generally speaking, it is not difficult to upgrade machinery and equipment. Great varieties of basic machinery are available in Malaysia. The industries can also import machinery at a low price form NIES, especially from Taiwan.

For moulds and dies, specific types of expensive machines such as EDM (general-purpose EDM and CNC-EDM), wire-cut EDM, forming grinders, profile grinders, CNC machining centers, precision measuring equipment , and two and three dimensional measuring equipment are needed. In Japan, the mould and die industry has shifted from a technology industry to a process industry. Most Japanese mould and die manufacturers are small-scale firms having 20 to 30 employees. The investment in machinery and equipment amounts to more than 100 million yen per firm on average. Interest expenses and depreciation for such investment are a heavy burden for the mould and die manufacturers in Japan.

The labour cost in Japan is among the highest in the world. The mould and die industry, hence, tends to promote factory automation with the introduction of precision equipment in order to supply precision moulds and dies at a low price. Although Malaysia still has a relatively cheap labour force. Indonesia has an even cheaper labour force. It is not appropriate to consider the competitiveness of the Malaysian industry simply from the point of labour cost. Hardware should be given proper consideration from the viewpoint of upgrading.

In the mould and die industry in Malaysia, a limited number of companies have introduced excellent machinery and equipment and the precision level of their products is high. But most manufacturers can not afford expensive machinery. Their general machine tools have been used for around 10 years and their precision level has decreased. In addition, they have been used roughly.

It seems that the present production system relying on manual work could not catch up with the increase of demand when the business uptrend continues. The industry can meet the expansion of demand simply by increasing the number of machines and equipment. But, in order to pursue the take-off of the industry, it is desirable to invest in machinery for the upgrading of production technology and to realize the upgrading of precision level and the improvement of productivity.

It is obvious that the mould and die industry should invest in machinery and equipment to keep up with the increasing demand. The best consideration should be paid to the course of machinery and equipment investments for the realization of industrial development.

The introduction of CNC machines should be decided based on well-established planning. Managers point out the lack of manpower and machinery as the major problems concerning the precision level and delivery. That is partly true. But the overloaded use or inappropriate use for the improvement of precision level and productivity often becomes the major problem. New expensive machinery seems to contribute to the expansion of production, but not to the improvement of precision level and productivity.

To improve the precision level and productivity as well as to increase production and to realize horizontal international specialization are the targets of the Malaysian mould and die industry. Investments in machinery and equipment should be made in accordance with those purposes.

To achieve those targets, it is first required that the Malaysian government provide institutional supports such as the Loan Scheme for Machinery and Equipment Modernization and the Loan Scheme for Machinery and Equipment Improvement. Second, the development of substantially cheap precision machinery is needed. Even Japanese mould and die manufacturers are pressed for the depreciation of a CNC machine, which costs more than 20 million yen. The depreciation burden is larger for Malaysian manufacturers.

The precision level of existing general-purpose machine tools has deteriorated. Malaysian manufacturers need to purchase new machinery. It may be worth considering the replacement of two existing machines with one new machine which has twice the functions of an existing one.

A higher rate of investment in equipment for high precision production facilities is judged to be necessary for the ultimate "take off" of the moulds and dies industry.

*** Graphic chart of machinery & equipment investment ***

	Present	Three Years Later	Five Years Later
Ratio of general-purpose machine tools	90% or more	70% or less	60% or less
Ratio of precision machines	10% or less	30% or more	40% or more

2-3-2 Software

The mould and die industry in Malaysia has a lot of problems concerning their field of software. But the development of software is the key of the future development of the industry. The development of software means the development of skilled or trained workers, for one thing, and the successful transfer of technology, for another.

The development of software lags far behind the required pace of economic development. Personnel training is left to each private company partly because the public organizations provide insufficient opportunity of vocational education and training. Each company has to train its own employees how to manufacture moulds and dies from the beginning.

At present, there are some public sector facilities such as MIDEC (the Metal Industry Development Centre) established in SIRIM (the Standards and Industrial Research Institute of Malaysia), CIAST (the Centre for Instructor and Advanced Skill Training) and ITI (the Industrial Training Institute), which have educational or training programs on moulds and dies.

Talking the case of SIRIM, SIRIM has trained a considerable number of trainees with the machinery and equipment for the production of moulds and dies assisted by JICA and Japanese experts. Japanese experts left at the expiration of the contract term with JICA. Although SIRIM still continues training programs, it seems necessary to examine the education and training programs of mould and die technology carried out by Japanese experts. ITI also has education and training programs.

In addition, the vocational division of MARA is, in earnest, considering the start of educational programs of mould and die technology. The Ministry of Youth and Sports plans to establish the Advanced Training Centre in the Engineering Industries Complex,

which will provide advanced-level training programs, in August 1990, with the cooperation of the Indian government.

The necessity of education and training programs on moulds and dies is fully recognized. For the development of education and training facilities, short-term and long-term measures would be needed.

As a short-term measure, the expansion of existing facilities is recommended. The shortage of technicians is an urgent problem of the Malaysian moulds and die industry. It would hinder the country's economic development. The job-hopping of technicians would increase due to intensifying recruiting activities.

The existing facilities expansion program, which is recommended as a short-term measure, would place more importance on accepting dispatched experts because large investments in hardware would not be necessary.

As a long-term measure, there must be the establishment of new training facilities. Although there are some training facilities around Kuala Lumpur, training facilities are lacking or insufficient in local areas. In the Penang area, where the electronic industry is rapidly developing, for example, the demand for trained mould and die workers is very high, and some of the firms are reportedly examining the possibility of establishing jointly a training facility. The Penang Development Corporation has the plan of establishing the Tooling Centre. From this example, it is clear that existing education and training facilities do not meet the increasing demands for trained workers which keeps pace with the economic development.

As for training programs, it is recommended to classify them into elementary courses, intermediate courses, and advanced courses. Polytechnics would provide an elementary course supplementing facilities and experts. An intermediate course is an intensive course which would give practical education and training to graduates from an elementary course. An advanced course means the course which would teach high-grade precision mould and die technology.

There is a way to teach separately curricula of which each course is composed in order that trainees can learn the course in a short period. Those courses should be properly positioned in the overall long-term program in order that trainees can finish all curricula.

Curricula should place importance on practical training of practical techniques such as designing techniques from basic punching dies to precision progressive dies, machine handling of EDM or angular mould grinding, and problem-solving techniques in the processing at workshop. It is necessary that experts examine details of those curricula before training courses start.

The courses should be open to those workers having 2 to 4 years of practical experience as well as inexperienced workers. Except for elementary courses, training programs should be intended for workers with 2 to 4 years of practical experience and graduates from primary education. The key problem is how to make a system of programs which employees of companies can attend without difficulty. The experience of CIAST shows that companies do not send workers to a program when the program period is long. This is because the shortage of skilled workers is the problem at most companies.

The other important point is "textbooks" or "manuals", which are dispensable for transferring technologies. Textbooks or manuals on press and plastic moulds and dies should be systematically prepared.

Managers have recently tended to send workers to training programs in spite of the shortage of manpower. On the other hand, requests to send experts to company have tended to increase. The government should devise a scheme to meet those requests from companies.

The development of textbooks and manuals should be examined as the theme of a project. The development of textbooks and manuals requires a fair amount of work. This is not a task which can be achieved by only an expert.

Some Japanese experts compiled some textbooks which have been used in MIDEC or CIAST. However, to prepare textbooks was a time-consuming task.

Once a wide variety of textbooks and manuals are prepared based on the general framework, experts or trainers can use them at any time. When the framework of textbooks and manuals is well-established, application manuals can be easily developed to meet specific requirements.

Textbooks printed in Japan, in-house manuals of Japanese companies, and those visual devices such as VTRs would be very helpful. The distribution of those educational materials to technicians in Malaysia should be promoted in order to improve their level of work.

Training programs should place importance on transferring practical techniques instead of on teaching bookish knowledge. Along with this principle, workshop-style training programs should be included in the overall training programs.

The development of programs mentioned above would contribute to solving the shortage of skilled labour, which causes the high frequency of job-hopping, and to the improvement of the reluctance to exchange information, which hinders industrial development.

There are some foreign companies which have manuals which regulate in-house education, employees' skills, and pay. These manuals would serve as references for the development of curricula which would meet the requirements of the Malaysian mould and die industry.

There is a program which sends Malaysian trainees overseas. This program should be enlarged.

Now is the time to establish education and training programs from the long-term standpoint because the Malaysian mould and die industry has a ten-year history. Projects to expand or create integrated education and training facilities, based on the long-term program, not only in the metropolitan area but also in local cities are required in order to make use of individual characteristics of each area. An example is the project that would establish a training centre specialized in high-grade technology with the introduction of new and high-grade machines producing precision moulds and dies for metal working and curricula in Penang in order to contribute to the development of the electronic industry. In other words, the characteristics and purposes of the training programmes should be clear.

The Directions of Recommended Software Development

① **Personnel Education**

Advanced technicians: To master multi-skills → Overseas Training → Practical applications to work → In-company practical education →

↑ From this stage, to transfer skills to other employees

Operation technicians: To master a single skill ——————→ In-company practical education → To improve the skill → Practical application to work

↑ To master other skills, if necessary

② **Transfer of Skills**

Long-term curricula → A master plan for the acquisition of multi-skills
Program period is 2 - 3 years

Short-term curricula → For the acquisition of a single skill
Program period is 1 - 6 months

③ **Institutional Development**

Objective	Measures
The expansion of existing institutions	To expand personnel and facilities
To establish the individual characteristics of new institutions	To create advanced institutions by specifying the objective of each institution
To expand the basic education system	To reinforce the capabilities of POLYTECNIC and ITI

2-4 Business Administration and Sales Strategies

The mould and die industry in Malaysia is still very young, having a history of around 10 years. Most of the managers of mould and die firms are also young. The managers interviewed in Malaysia were mostly in their thirties or forties. The average age of workers in the mould and die industry is also as young as around 30. In comparison, the average age of the workers in the mould and die industry in Japan is estimated at the late forties. Due to this short historical background, most of the firms interviewed were managed in very premature ways putting most of the efforts in both sales and production, and modernized management systems were scarcely introduced. With the development of the business volume, however, most fo these firms would soon be faced withe the necessity of introducing modern management systems.

First, the introduction of a "Quality Control" system is needed in the area of production control. Although "QC" systems and other modernized production control measures are already established in relatively large-scale firms or foreign affiliated firms, in a majority of local firms, the introduction of these production control measures is in a very primitive stage. Although there are even firms having no idea of what a "QC"is, which is not unusual at their developing stage, it is judged that Malaysian manufacturers have enough managerial base to accept the "QC" system in their production management. The extension of "QC" activities would have to be soon started through organized campaigns or PR activities. In Thailand, the spread of "QC" activities through nation-wide campaigns has had a considerable effect in recent years.

Second, the introduction of modern business administration systems is needed through the education of executives of small-and -medium size mould and die firms. Major items of modern business administration are the accurate control of direct production costs (cost accounting system), and the production flow control for accurate delivery of the products. In order to effect the introduction of these modern management systems, the invitation of foreign experts in the field or case studies of advanced firms both in Malaysia and abroad is needed. For another, it would be promoted by the active exchange of experience or information among executives in the mould and die industry. In Japan, such nation-wide industry associations as "Japan Die and Mould Manufacturers Association" or "Japan Metal Stamping Association" play an active role. Recently, the business information exchange has become active not only in the same industry group but among different industry groups aiming at the R&D of new products and new business investment chances. Further, such organizations as "Japan Junior Chamber Inc." (J.C.)

contribute largely to the development of young executives of the firms in Japan. The Malaysian Mould and Dies Manufacturers Association is not a unified industrial organization. Rather, it is nothing but a group included within the Mould & Die and Precision Engineering Group which is one part of the Federation of Malaysian Foundry & Engineering Industries Associations (FOMFEIA). There is a total of 53 companies in the group, but even including the companies outside of the mould and dies industry, the level of activity is low because some of them are located in regions outside of Kuala Lumpur and Penang. In Malaysia, also, it is considered to be essential for the development of the mould and die industry to expand the industry association and to activate the information exchange both of management and of technology.

As for sales, the demand for moulds and dies is expanding largely from foreign investors located in FTZ. From the nature of the products, the best sales strategy for mould and die manufacturers would often be to locate near their customers and give flexible services. In this view, those local firms located in the Penang area have advantages and have succeed in their sales strategies. The major problem in these firms is the delivery period, which reaches around 3 months at present, due to the rapid increase of the demand. For reference, the average delivery period in Japan is 1-2 months. In case the Malaysian manufacturers could not make the present delivery term shorter than the present 3 months through up-grading productivity, it would be very difficult for them to compete with new investors aiming at the growing demand for moulds and dies in the Penang area. Under the present environment of growing demand, sales seem to grow automatically, and sales efforts are apt to be neglected. For the purpose of increasing future competitiveness, further efforts would have to be placed on the improvement of the total capability of firms including the establishment of sales networks.

The future target of mould and die manufacturers in Malaysia would have to be directed in such a way that they could supply a stable quality of products both for the foreign investors and for the local manufacturers. At present, the tendency is often observed that the quality of products is low due to the low price offered for the products. A sales strategy which would cut down the above vicious cycle would be required. As a part of this strategy, efforts should be made that orders should be placed based on the exact drawings, and once the drawings are set, no change should be made during the stage of processing.

The following table shows the subjectively evaluated levels of local mould and die manufacturers in the field of business administration and sales capabilities.

*** Graphic chart of management ***

	Achievement Ratio 0% 50% 100%	
Business administration capability	→	(30~50%)
Introduction of modern management system	→	(10~40%)
Cost analysis	→	(50~60%)
Managers' aggressiveness	→	(80~100%)
Established sales system	→	(50~60%)

2-5 Relations with Peripheral Industries

2-5-1 Metal mould and die materials

It is the metal mould and die material industry that should be taken up first as one of the related industries. Characteristically, moulds and dies must use many kinds of special steels and have the problem of ensuring a stable supply of the materials. Fortunately, ASSAB Steels of Sweden is established as the supplier of standard materials in Malaysia. Japanese firms supply extremely limited quantities of metal mould and die materials in limited categories.

It is impossible to produce these materials in Malaysia in consideration of demand in that country, or even in Southeast Asia as a whole. It may be necessary to continue importing them over some years in the future. If demand increases, competition will occur, prices will stabilize and varieties will increase.

According to ASSAB's catalog, their products form a sort of lineup including prehardened steel, die steel and stainless steel. Materials are not divided into several kinds within one family as those in Japan are. It appears that this is attributable to the fact that limited demand makes it difficult to stock many kinds of materials.

As long as ASSAB and Japanese products are used, no problem will occur in terms of the accuracy of materials supplied (materials are usually supplied in previously-processed round and square forms in several sizes). Locally processed materials contain ones of inadequate accuracy (inaccurate in units of mm). No matter how short their lead time and how low their prices are, they are useless.

2-5-2 Metal mould and die parts

HASCO of West Germany has been the leading supplier of standard parts for moulds and dies (guideposts, guide bushes, injection pins, hot-runner systems) and Japanese products have been available only in small quantities. Malaysians feel that these standard parts are relatively expensive in consideration of the price level in that country. Many companies use in-house parts, buying important parts from outside suppliers. These standard parts are important in a certain sense and provide an effective means of standardization in the mould and die industry. If the industry expands and has to shorten the lead time, naturally they are forced to use many standard parts. Standard parts are available in abundance in advanced mould and die producing countries, their accuracy and

reliability are very high. In Thailand, parts manufacturers are developing by themselves. In the near future, even in Malaysia, domestic production will pay off.

2-5-3 Heat treatment

Heat treatment is important to both metal working and plastic moulds and dies. Since there is an emerging tendency to switch to wholly-hardened moulds and dies, whether metal working or plastic, the superiority of the heat treatment division is gaining importance.

According to surveys on the present condition of heat treatment in Malaysia, there are very few heat treatment factories for moulds and dies in Malaysia. The existing factories lack reliability, and Singaporean manufacturers are commissioned to produce moulds and dies which are required to be accurate. It is presumed that perhaps they cannot handle hardening and tempering and that they do only annealing. It may be possible to install a small electric furnace and heat-treat ASSAB's XW41 (equivalent to SKK11 of JIS) which is widely used for precision parts, if they are small. However, it requires a large sum of money to install equipment to heat-treat large parts. This is not realistic. It is necessary to develop an industry specializing in heat treatment.

The quickest and easiest way is to install heat treatment equipment at training institutions and open it to the private sector. For example, MIDEC in SIRIM has sophisticated heat treatment equipment. This may serve a double purpose if outside specialists are allowed to make use of it.

2-5-4 Metal mould and die users

As mentioned earlier, major users of metal working moulds and dies in Malaysia are semiconductor manufacturers in FTZ mainly in Penang. It is said that the Malaysian semiconductor industry ranks first in world production volume. In 1986, there were 35 semiconductor manufacturers, 16 of which were located in Penang.

Table IV. 2-1 Semiconductor Manufacturers by Location

State	Operation	Non-operation	Preparing	Total
Penang	16	1	–	17
Selangor	11	–	2	13
Negri Sembilan	2	2	–	4
Melaka	3	–	–	3
Kedah	1	–	2	3
Johor	1	–	2	3
Perak	1	–	1	2
Kelantan	–	1	–	1
TOTAL	35	4	7	46

Source: MIDA

The second largest user is the home electric appliance industry. Malaysia is the world's third largest exporter of room air conditioners. This is the result of Matsushita and Toshiba having shifted their production bases to Malaysia. Plastic moulds are used for manufacturing plastic frames of TV sets and plastic parts of irons.

Table IV. 2-2 General Condition of the Electric and Electronic Industry

		Firms	Production (M$1,000)	Employees
Refrigerator, air conditioners, etc.	83	11	361,183	3,705
	84	9	225,873	2,355
	85	10	218,269	2,566
	86	12	349,493	3,367
TVs, radio audio products	83	16	594,086	9,693
	84	18	698,415	10,811
	85	18	742,587	9,787
	86	15	792,257	11,144
Semiconductor, IC, etc.	83	57	4,299,835	68,039
	84	56	5,369,512	68,717
	85	54	4,771,037	53,354
	86	55	5,694,325	56,459

Source: Monthly Industrial Statistics

3. Mould and Die Industry of Asian NIES, Japan and Major Countries

3-1 South Korean Mould and Die Industry

The Asian NIES and Japan's Mould and Dies Industry

The mould and dies third country survey covered Hong Kong and Singapore in addition to Korea and Taiwan which are competing countries, both showing strong growth in production and exports. In Korea and Taiwan, it is extremely desirable that the new production machines, CNC, EDM, CNC wirecut EDM, and CNC Machining Centre, be introduced. In Korea, worker training is provided in the mould and dies design department of universities and the mould and dies department of occupational training schools. In addition, Taiwan is also patting strength into training through the establishment of mould and die specialist schools.

The conditions in Hong Kong and Singapore are similar, and they are working to improve the level of worker training and technology. These combined joints were focused on in the survey.

The Japanese mould and dies industry began genuine growth during the long period of high level training in the 1950s. As in every country in the world including Malaysia, companies with fewer than twenty employees made up over 90% of the total and the industry scale was small. However, through the introduction of the latest machinery and expansion of training programs in the company. Japan is now the leading mould and dies producing country in the world.

The requisites for growth, present conditions such as the level of technology, and future requirements for the industry in Japan shall be discussed.

(1) Development

At the end of the Second World War, technology for mould manufacturing was extremely out of date in Korea and there was little capacity to fulfill demand. This situation continued up until 1960. As a result, the majority of moulds and dies were imported from overseas.

With the promotion of industrialization policies since 1960 and the need to preserve secrecy in relation to the defense industry, the domestic mould and die industry began to develop, and this has provided the base for today's mould and die industry.

Along with the changes which were made to the industrial structure in the 1970s and the growth of export-oriented industries the number of companies involved in the industry increased to about 350. During the period of rapid growth in the 1970s and then while overcoming the slump in the first half of 1980, the number of mould and die manufacturers increased further to 800 companies. At that time, the domestic production of types of machinery increased substantially due to government assistance and preferential financial measures, and greater importance was attached to the mould and die industry as a result.

By the period of rapid economic growth experienced in the latter half of 1985, the number of companies in the industry had reached 1,200. (There are no official figures available. JETRO's Seoul office estimated 1,200-1,500 companies during 1985.)

(2) Industry Characteristics

1) As for the scale of companies specializing in mould and die manufacture, there are many which are small, and 82% of companies have a work force of less than 20 workers. The production value of these manufacturers is worth just less than 40% of the total value, with medium-sized and larger companies accounting for the major part of production. The ratio of companies classified by employee number is as follows:

Number of Employees	Percentage
5- 9	54
10-19	28
20-49	14
More than 50	4

Source: Summary of Korean Mould and Die Industry, 1987

2) As for the proportion of companies involved in the production of items, press die manufacturers account for roughly 60%, and manufacturers of plastic moulds 27%. Many of the companies which produce press dies are involved in other production as well, whereas most of those producing plastic moulds specialize in such moulds.

Ratio of Specialization	Less than 50%	50-99%	100%
Manufacturers of Press Dies	194	18	37
Manufacturers of Plastic Moulds	26	13	74

Source: 1982 survey by the Medium and Small Enterprise Promotion Corporation—used for all tables below

Note: The survey covered 419 companies, and the companies included in the table account for 86% of that number. Out of the 419 companies there were 127, or 30%, which specialized 100%

3) Looking at production items classified according to production value, plastic moulds accounted for the largest amount. Combined with press dies they account for two thirds of total production value. The ratio of production value for manufacturers with a specialization ratio of 50% or higher is as follows:

Press Dies	31%
Plastic	46%
Glass	8%
Rubber	4%
Cast and Forged	4%
Other	7%
Total	100%

4) Production value according to the location of manufacturers is as below. More than half are located in the Seoul area.

Seoul	53%
Pusan	23%
Kyeonggi	7%
Other	17%

Source: Economic Planning Institute

5) The majority of users of moulds and dies produce them in-house. This is particularly so in the case of automobile manufacturers, the majority of which do so for reasons related to quality, manufacturing time, and secrecy. It is estimated that they produce 80% of their required moulds and have 20% produced outside.

	In-house Ratio	Outside Ratio	(Including Imports)
Press Moulds	57	43	(21)
Plastic Moulds	27	73	(16)
Die cast Moulds	66	32	(2)
Average (Includes Other)	60	29	(13)

Source: Industrial Research Institute

6) As for equipment, the majority of mould and die manufacturers do not have equipment which can carry out heat treatment and surface treatment, and so have these processes undertaken outside. (1984 survey by Industrial Research Institute)

The ratio of companies which possess NC lathes and electric discharge machines is still low despite the fact that the machines have begun to be introduced lately in order to improve precision and speed. Out of 100 companies, 8 were found to have NC lathes and 15 had electric discharge machines (Source: same as above).

7) The most important factor in the manufacture of moulds and dies is consultation between design experts and the responsible persons from the manufacturing site, and improvements are required in this regard. One problem which the industry faces is the many hours which are required for making alterations as a result of inadequate consultation. Because costs increase as a result of alterations, it is quite common for remanufacture to take place.

Two reasons for this are the lack of experience of the technical experts and the low ratio of employees who stay with one employer. This low ratio hinders the development of skilled workers. In the case of manufacturers specializing in moulds and dies, not many employees stay long as the ratio of employees who have less than 3 years' service is 91% for press dies and 82% for plastic moulds. (Source: Medium and Small Enterprise Promotion Corporation)

(3) Demand and Supply Trends

1) The demand and supply of moulds and dies in South Korea increased considerably every year and supposedly surpassed the 4 trillion won mark in 1987. (Table IV. 3-1)

2) Production fared the same as the trend in demand and supply, and in 1987 supposedly reached 3 trillion won. (Table IV. 3-1)

Table IV.3-1 Trends in supply and Demand of Moulds and Dies in South Korea

(Unit: Million won)

Item	Year	1983	1984	1985	1986	1987
Supply	Production	67,508	124,812	151,989	(219,148)	(324,018)
	Imports	25,269	35,207	57,758	124,195	95,935
	Total	92,777	160,019	209,747	(343,343)	(419,953)
Demand	Domestic	81,477	147,779	195,362	(332,264)	(387,702)
demand	Exports	11,300	12,240	14,385	21,079	(32,251)
	Import Reliance	27.2%	22.0%	27.5%	36.2%	22.8%
	Export Ratio	16.7%	9.8%	9.5%	9.6%	10.0%

Source: Economic Planning Board, Industrial Statistics and Tariffs Agency Trade Statistics Yearly

3) There are no production statistics for moulds and dies by type. According to shipping figures put out by the Economic Planning Institute in 1984, out of 1.123 trillion won, plastic moulds accounted for the largest value with 31.9%, followed by press dies (21.1%), casting moulds (4.9%), and die cast moulds (3.1%). (Table IV. 3-2)

Table IV.3-2 Shipments of Molds and Dies by Type

Type	Ex-factory Value (Million won)	Share (%)
Press Dies etc.	23,742	21.1
Plastic Moulds	35,740	31.9
Dies Cast Moulds	3,500	3.1
Forging Dies	6,471	4.9
Other Moulds and Dies	43,837	39.0
Total	112,290	100.0

Source: Economic Planning Agency, Industrial Statistics (1984)

(4) Exports and Imports

1) Exports

As shown in Table IV. 3-3, from a value of US$14.2 million in 1983, exports of Korean moulds and dies increased sharply to US$24.8 million in 1986, and then US$39.6 million in 1987.

Concerning the different types of moulds, rubber and plastic moulds comprise the larger part, and in 1987 accounted for 63.8% of mould and die exports. (Table IV. 3-3).

Table IV.3-3 Exports of Moulds and Dies by Type

(Unit: US$1,000)

	1983	1984	1985	1986	1987
Punches & Dies	215	649	494	720	1,006
Metal Forging Moulds	1,043	1,226	840	480	2,001
Moulds for Metal and Metal Carbides	996	606	1,454	3,668	3,718
Glass Moulds	435	230	11	32	101
Moulds for Forming Mineral Materials	2,204	67	121	251	103
Rubber or Plastic Moulds	4,756	5,111	7,081	13,485	25,241
Others	4,512	6,954	6,921	6,153	7,385
Total	14,161	14,843	16,922	24,789	39,555

Source: Tariffs Agency

As for the country of destination, the most went to Japan, followed by the United States and then Malaysia. (Table IV. 3-4)

Table IV.3-4 Imports of Moulds and Dies Type by Country (1986)

(Unit: %)

Type	Main Export Destinations
Punches & Dies	Japan (49.5), Saudi Arabia (19.8), U.S. (9.1)
Metal Forging Moulds	Japan (43.5), Malaysia (15.3), U.S. (14.8)
Moulds for Metal and Metal Carbides	Japan (50.6), Indonesia (10.1), U.S. (7.3), Malaysia (7.1)
Glass Moulds	U.S. (68.8), Japan (28.1)
Moulds for Forming Mineral Materials	Bangladesh (54.7), Indonesia (21.5)
Rubber or Plastic Moulds	Japan (47.7), U.S. (7.2), Malaysia (7.0)
Total	Japan (46.6), U.S. (15.1), Malaysia (9.0)

Source: Korean Trader's Association

2) Imports

Imports increased sharply from a value of US$31.66 million in 1983 to US$146 million in 1986. But they decreased to US$117.7 million in 1987. (Table IV. 3-5) Due to the increase in overall production, the ratio of dependence on imports compared to total demand decreased, and in 1987 are estimated to have accounted for 22.8 % of total demand.

As for the types of moulds and dies which are imported, moulds for plastic & rubber and punches and dies comprise the larger part, and accounted for 41.4% and 41.3 % respectively of imports in 1987. (Table IV. 3-5)

Table IV. 3-5 Imports of Moulds and Dies by Type

(Unit: US$1,000)

	1983	1984	1985	1986	1987
Punches & Dies	8,363	13,766	25,867	83,427	48,580
Metal Forging Moulds	2,261	783	3,224	6,262	2,104
Moulds for Metal and Metal Carbides	3,479	3,683	8,232	8,232	9,425
Glass Moulds	1,615	1,280	522	1,407	3,673
Moulds for Forming Mineral Materials	214	4,846	478	783	908
Rubber or Plastic Moulds	13,933	15,495	26,813	42,823	48,728
Others	1,798	2,779	2,809	3,120	4,249
Total	31,663	42,632	67,945	146,054	117,667

Source: Tariffs Agency

The main countries from which they were imported are Japan, the United States, and West Germany. (Table IV. 3-6)

Table IV.3-6 Trends in Imports of Moulds and Dies

(Unit: %)

Type	Main Export Destinations
Punches & Dies	Japan (96.6), U.S. (2.0), W. Germany (0.9)
Metal Forging Moulds	Japan (96.6), U.S. (2.0), Denmark (1.8)
Moulds for Metal and Metal Carbides	Japan (71.5), West Germany (16.6), U.S. (9.4)
Glass Moulds	U.S. (81.1), Japan (18.2)
Moulds for Forming Mineral Materials	Japan (55.2), W. Germany (34.7), Italy (4.8)
Rubber or Plastic Moulds	Japan (86.4), U.S. (9.1)
Total	Japan (90.4), U.S. (5.6), West Germany (2.2)

Source: Korean Trader's Association

(5) Industries Using Moulds and Dies

Out of the total demand and supply of moulds and dies, electric and electronic industries accounted for the largest value with 66.4% followed by the machinery industry (13.9%), the automobile industry (7.9%) and others (18.8%). (Table IV. 3-7)

Table IV. 3-7 Industries Using Moulds and Dies

(Unit: million won)

Industry	Turnover	
	amount	ratio
Electric and Electronic	1,625	66.4%
Metal Processing	340	13.9%
Automobiles	194	7.9%
Other Industries	289	11.8%
Total	2,448	100.0%

Source: Korea Mould and Die Cooperative Association

According to a survey conducted by the South Korean Industry Research Institute (KIET) in 1984, the major users of moulds and dies produced 58% of their requirements in-house and depended on outside contracting or imports for the remaining 42%. (Table IV. 3-8)

Table IV. 3-8 Method of Procuring Moulds and Dies by Companies

(Unit: %)

	Total Value of Molds and Dies Used	Fabricated In-House	Ordered Outside	Imported
Press Dies etc.	100.0	57.4	21.3	21.2
Plastic Moulds	100.0	26.5	57.4	16.0
Diecast Moulds	100.0	66.2	31.9	1.9
Others	100.0	79.8	13.3	6.9
TOTAL	100.0	57.7	28.9	13.4

Source: Industrial Research Institute

(6) Production Technology

With the exception of objective data, there is no suitable data available which can be used to judge the technical level of the mould and die industry. The following have being used as objective data: A- equipment; B- precision and performance of moulds; C- processing and design technology; D- management know-how for production stages etc; and E- personnel.

1) Possession of Processing Equipment

According to the survey undertaken in 1982 by the Medium and Small Enterprise Promotion Corporation, which included 419 companies, the averages for equipment possessed by each company were as follows: general lathes- 2.42; bench drills- 2.45; vertical milling machines- 0.96; and horizontal milling machines- 0.27. Manufacturers which specialized in the manufacture of moulds and dies possessed a relatively large number of vertical milling machines, electric discharge machines, mould grinding lathes, radial drilling machines, and engraving machines. (Table IV. 3-9)

Table IV. 3-9 No. of Main Facilities Owned per Company

(Unit: No. of Machines)

Name of Machinery	Overall	Specialized	Name of Machinery	Overall	Specialized
General Lathe	2.42	0.86	Horizontal Boring Machine	0.04	0.04
NC Lathe	0.08	0.02	Vertical Boring Machine	0.05	0.02
Other Lathes	0.38	0.20	Surface Grinder	0.70	0.53
Vertical Milling Machine	0.96	1.30	Forming Grinder	0.51	0.61
Horizontal Milling Machine	0.72	0.88	Cylindrical Grinder	0.22	0.10
Universal Milling Machine	0.37	0.38	Universal Tool Grinder	0.11	0.09
Engraving Machiine	0.17	0.30	Tool Grinder	0.17	0.12
Tabletop Boring Machine	2.45	1.97		0.14	0.08
Radial Borning Machine	0.44	0.46	Shaping Machine	0.09	0.06
Other Radial Boring Machines	0.25	0.18	EDM	0.15	0.18

Source: Small and Medium Enterprise Promotion Corporation

Generally speaking, mould and die manufacturers do not possess sufficient machinery and equipment. Although the leading manufacturers have been modernizing and automating their equipment and have introduced NC wire cut electric discharge machines, CAD, and 3-dimensional measuring machines, the majority of manufacturers mainly use specialist machines.

2) Precision and Performance

Table IV. 3-10 provides a comparison of the quality levels of Japan and Korea, and as is shown, Korean-made moulds and dies are generally poorer in quality than Japanese-made products. Processing precision is up a unit lower than in Japan, and the durability of Korean-made moulds and dies is only half of that of Japanese-made products. Korean-made moulds are also of a lower level than Japanese products in regard to appearance and surface treatment.

Table IV. 3-10 Comparison of Quality of Moulds and Dies of Japan and South Korea

Classification		South Korea	Japan
Machining Accuracy (mm)		0.010	0.003
Surface Treatment (S)		6.3	2.5
Hardness (HRc)		30 - 58	66
Durability	Press	500,000 X	1,000,000 X
	Plastic	300,000 X	600,000 X

Source: South Korean Mold and Die Industry Handbook 1986
Note: X means times of shot.

3) Processing and Design Technology

• Design technology

The design technology of Korean mould and die manufacturers is such that although the producers can design moulds and dies through imitation, the companies lack the required development skills to design them themselves. Of course, though there are some companies which are capable of design and development, and there are many cases where requests come from the production site for alterations to be made to plans which have been drawn up due to insufficient understanding of the processes involved on the part of the designers. Also, the theory behind the design is not commonly used when designs are made, and standards for designs have not yet been established. As a result, design takes

a long period of time, which often leads to an inability to meet delivery dates. There are, however, some manufacturers who use CAD technology.

• Processing technology

The standard of processing technology is rising steadily in South Korea, and there are some specialized areas that are comparable with those of advanced countries. However, the majority of mould and die manufacturers depend on specialist machine tools and are behind in processing technology and, as already mentioned, the level of precision is lower than that in Japan. In particular, Korea lags behind in technology for surface treatment and heat treatment, which has led to low levels of precision and durability for moulds and dies.

Insufficient tools, inadequate tool management technology, insufficient usage of measuring tools, and a lack of appreciation of the importance of precision are some of the factors which have contributed to a low level of processing technology. There is also insufficient understanding of the fundamentals of the performance and operation of machines. A lack of understanding as to the properties of materials which are used and the inability to choose the appropriate materials for each type of mould and die are also major problems.

4) Management Technology for Production Stages

Because there is no standardization of parts, many components have to manufactured in-house. Most of the companies with more than 30 workers face problems related to the management of production stages. These problems can be attributed to insufficient know-how for checking the stages from design to delivery, insufficient quality-control technology and insufficient knowledge of cost calculation.

5) Personnel

There are no accurate figures covering the total work force of the mould and die industry primarily because the individual companies themselves do not have such figures.

According to the Korean mould, die, and tools industry union, as of the end of 1982 the level of education received by 59% of employees working in the mould and die industry was junior high school or lower. 37.7% graduated from high school, and 5.4% were university graduates (includes junior colleges and technical institutes). As for the proportion of technicians and skilled workers, as little as 9.3% of the work force were technicians, 68.2% were skilled workers, and 20.2% apprentices. With the exception of a small number of skilled workers and apprentices who had graduated from high school,

most of this group had received only a low level of education equivalent to the junior high level or lower.

As shown in Table IV. 3-11, 83.5% of the total work force had less than 3 years continual service, 11.4% had between 4-5 years, 4.4% had between 6-10 years service, and only 0.7% had more than 10 years service.

Table IV. 3-11 No. of Employees by Mould and Die Type and by Years of Continuous Employment

(Unit: Persons, %)

	Total	3 years or less	4 to 5 years	6 to 10 years	10 years or more
Press	903 (35.3)	819(90.7)	72(8.0)	10(1.1)	2(0.2)
Plastic	1,143(40.7)	937(82.1)	148(12.9)	54(4.7)	4(0.3)
Diecast and Others	509(20.0)	378(74.3)	70(13.7)	49(9.6)	12(2.4)
TOTAL	2,555(100.0)	2,134(83.5)	290(11.4)	113(4.4)	18(0.7)

Note: 1. Figures in parentheses in the "Total" column indicate the share in the total number of employees.
2. Other figures in parentheses indicate the share in the number of years of continuous employment by type of mold and die.

Source: Small and Medium Enterprise Promotion Corporation (1982)

(7) Promotion Policies of the Mould and Die Industry

1) Training of Technicians and Skilled Workers.

Since the end of the 1970s the Korean mould and die industry has suffered from a shortage of skilled workers, and in order to hold on to personnel, companies have been providing education within their own companies as well as looking for people who have had overseas training. Once into the 1980s, educational training was launched by educational facilities, public organizations, occupational training institutes, and facilities established specially by individual companies. The shortage of highly qualified technicians also became very severe at this time, and organizations were established for training technicians.

In South Korea, there are 2 open universities for technicians and skilled workers, one of which is the Kyeonggi Industrial Open University. The 3 universities specializing in engineering produce 320 mould and die designers a year, and the Central Occupational Training Institute and 4 other organizations train 200 specialist skilled workers and technicians a year. An outline of the various facilities which train technicians is provided in Table IV. 3-12.

Table IV. 3-12 Training Facilities for Mould and Die Engineers

Facility	Department/Course	Training Period	Student No.s(yr)	Remarks
Kyeonggi Industrial Open University	Mould and die design	4 years	40	covers 1980
Pusan Industrial Open University	Mould and die design	4 years	40	established 1985
Yuhangule Industrial University	Mould and die design	2 years	80	established 1985
Cheonun Industrial University	Mould and die design	2 years	80	established 1985
Taeyu Industrial University	Mould and die design	2 years	80	established 1985
Central Occupational Training Institute	Mould engineering	2 years	30	covers 1968
Handouk Occupational Training Institute	Mould engineering	2 years	30	covers 1973
Hanbaek Occupational Training Institute	Mould engineering	2 years	20	covers 1978
KIMM	Metallurgical tool design	2 years	100	

Source: Minutes from the meeting of the special committee of the Korea and Japan
Medium and Small Enterprise Association

2) Technical Training and Factory Assistance

In June 1987 the government announced greater assistance through taxation policies and finance to raise the level of 7 technical areas to the standard of advanced countries by 1991. The areas which have been selected are: casting and forging, plating, heat treatment, surface welding, surface treatment, and staining.

According to a plan for basic production technology training which has been formulated by the Industry Promotion Agency, a grading system is to be established for these 7 technical areas and by 1989 the technical level of some 2,354 companies will have been evaluated and graded so that they will receive a rating of 1-3 or no rating at all. Also, selected companies will receive assistance related to taxation, finance, training technicians, and research and development.

- System of grading factories

By establishing criteria for processing technology, quality control, etc. and then dividing these criteria into grades, it is proposed that during the 3-year period from 1987 through to 1989 the technical levels of some 2,354 companies will be evaluated and divided into four groups- grades 1-3 and no grading. Products which make use of products manufactured by selected companies will be exempt

from export inspection. By half way through 1987, some 824 factories had already been graded.

• Assistance to selected companies

2,500 companies which are expected to experience high growth during the 5-year period from 1987-1991 are to be selected to receive technical guidance on quality control, measuring, and inspection analysis from the Korea Machinery Research Institute and regional Testing and Inspection Centers. 500 companies involved in 5 different areas have already received guidance relating to investment.

• Creation of specialized industrial estates

In order to promote specialization and cooperation separate estates have been planned and are currently under construction in 4 areas for the 3 technical fields of moulds and dies, plating, and casting. Long-term, low-interest finance is being provided for the construction of joint facilities for liquid waste treatment and for pollution prevention. 124 companies are expected to move into these 4 estates.

• Taxation and financial assistance

With due consideration to the fact that most of the companies moving into the estates will be small companies, import quota duties will be applied and favor will be granted to the companies in relation to the import of equipment, etc. which are difficult to import, such as machinery testing equipment. In addition, an import duty installment payment system will be applied to specified items, and premium rates for industrial accident insurance are to be lowered in order to lighten the burden placed on companies.

On the financial side, an "Industrial Technology Improvement Fund" is to be established to offer finance at an annual interest rate of 5% and with a repayment period of 10 years. There are also plans to establish a low interest rate long-term repayment "Pollution Treatment Facility Fund".

• Training technicians and skilled workers

A further 5 courses, including a mould and die course, are to be added to technical training centers for the purpose of providing education for a 2-year period for employees already working in factories. More efforts are to be put into sending technical experts overseas.

In order to improve the level of specialist education provided by university engineering courses, experts from overseas are to be invited to universities to help provide better technical training.

• Technological development

Assistance is to be provided to areas which are facing problems with technological development. As part of this, the number of researchers at the Korea Machine Research Center is to be supplemented. Also, research and development is to be undertaken in the 5 areas of moulds and dies, casting and forging, plating, heat treatment, and welding. 23 new research facilities are to be established.

• Assistance with inspection equipment

The National Inspection Center and regional industrial inspection centers are to be made available for use by companies which do not have adequate inspection equipment of their own.

3-2 Taiwan Mould and Die Industry

(1) Development

The Taiwan mould and die industry got off to a late start. Although there were some manufacturers which made moulds as well as other products before 1951, true mould and die manufacturers did not appear until after 1964. It is estimated that as of 1987, there were some 2,000 mould 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 moulds, and in the central region, there are many factories which produce forging moulds and moulds for shoes. In the south, there are many manufacturers which produce forming moulds 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 moulds 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 moulds and dies. However, the situation still continues in which the Taiwanese mould 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 mould and die manufacture. For example, no more than 70 EDM electric discharge machines had been installed by 30 companies.

As of 1987, the average mould and die factory used drilling machines, lathes, milling machines, surface grinders, grinding machines, electric discharge machines, and copy-milling machines. The larger factories had CNC milling machines, machining centers, ultrasonic grinding machines, and optical projectior. Also, some had die spotting press 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 moulds 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 moulds, engraving, electric discharging, and forming grinding.

4) The Taiwan mould 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 moulds 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) Labour Situation

1) The mould and die industry is a labour-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 moulds and dies. The small companies are not in a position to set up training courses, and 70% of mould and die manufacturers adopt the apprentice system.

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

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 mould and die manufacturers. In

Taiwan, 78% of technical experts working for mould 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 mould 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 mould 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 mould and die manufacturers are small in scale.

There are 525 companies which specialize in the manufacture of moulds 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 mould and die manufacture accounted for 0.5% of the total work force of manufacturing industries. A look at the mould and die industry's share of production value at that time, 0.2%, shows the considerable extent to which the industry was labour-intensive.

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

30% of manufacturers produce press dies and moulds for forging. However, since larger factories are producing their own moulds or finish-off moulds produced outside due to the importance of precision- and production-timing, the actual percentage of companies producing these moulds 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 mould 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 mould 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 moulds and dies in Taiwan has increased as a result of increased production activities by Japanese companies. This has brought greater in-house production of moulds 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 mould and die manufacture, and much is expected of such moves.

(5) Industry Policies

There are no industrial policies which are aimed specifically at the mould 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 mould and die industry is one industry which has been designated as a strategic industry, and policies have been established for mould 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 mould and die production increased sharply from NT$5.0 billion in 1981 to NT$15.0 billion in 1986, thus showing a 300% growth during the intervening 5-year period. In 1987 production of moulds and dies accounted for 0.54% of total production for the manufacturing industries. (Table IV. 3-13) This was a 26% increase over the previous year.

Among the different types of moulds produced, plastic moulds and press dies and forging moulds have shown the most rapid growth. (Table IV. 3-14) The reason for this is the marked growth of the electronics industry which has been responsible for the accompanying growth of the mould and die industry, one of its supporting industries.

Table IV. 3-13 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 IV. 3-14 Production of Moulds and Dies of Taiwan (by type)

(Unit: NT$1,000)

Year	Item	Production Value of Moulds and Dies	Year	Item	Production Value of Moulds and Dies
1982	Press and Forging Dies	1,120,806	1985	Press and Forging Dies	2,327,241
	Diecast Moulds	371,696		Diecast Moulds	771,789
	Drawing Dies	297,357		Drawing Dies	617,431
	Plastic Moulds	3,928,541		Plastic Moulds	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 Moulds	459,563		Diecast Moulds	979,011
	Drawing Dies	367,650		Drawing Dies	783,208
	Plastic Moulds	4,857,229		Plastic Moulds	10,347,403
	Total	7,070,202		Total	15,061,718
1984	Press and Forging Dies	1,671,511			
	Diecast Moulds	554,327			
	Drawing Dies	443,462			
	Plastic Moulds	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 IV.3-13

Table IV. 3-15 Mould 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

(7) Exports

1) The trade of Taiwanese moulds 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.

2) Plastic moulds account for the larger part of moulds and dies for export, and they accounted for 87% of total exports for 1986, which were worth NT$1.62 billion. (Table VI. 3-16) 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 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.

Table IV. 3-16 Imports and Exports of Moulds and Dies by Type (1986)

(Unit: NT$1,000)

Type	Exports	Imports	Difference
Press and Forging Dies	95,037	268,736	-173,699
Diecast Moulds	90,036	64,051	25,986
Drawing Dies	27,594	4,939	22,655
Plastic Moulds	1,407,703	986,184	421,519
TOTAL	1,620,371	1,328,910	1,620,371

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

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 moulds and dies from overseas. Because, among the Asian NIES, 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 moulds and dies, where reliable quality

is especially important, Japanese mould 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 moulds.

When moulds 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 mould once it has been completed. Because of this "remote control" type of system, Taiwan is not placed at a disadvantage in regard to mould 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 moulds 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 moulds 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 mould and die manufacture and maintenance. In this respect, Hong Kong is considered not to be as well off as Taiwan.

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 moulds and dies exported from Taiwan to Hong Kong.

7) Although Hong Kong's official trade statistics do not include statistics for mould 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 moulds 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 moulds and dies to Taiwan. As in the case of other Asian NIES, the importation of moulds 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 moulds 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 moulds. As these industries develop further, it is expected that import demand will continue to expand as the supply of moulds 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 moulds and dies.

3-3 Hong Kong Mould and Die Industry

(1) Characteristics

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

2) The price of moulds 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 moulds and dies. As 30% of the 3,000 plastic manufacturers have their own mould and die plants, the total number of mould 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 mould 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$519.56million, total production in 1986 was worth in excess of HK$2.0 billion.

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

3)Trade

1) Mould 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$519.56million. A further increase was recorded in 1987 when exports increased by 31.2% and were worth HK$681.90 million.

Table IV. 3-17 Imports and Exports of Moulds 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. Moulding Box for Metal Foundry and Moulds (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. Moulding Box for Metal Foundry and Moulds (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

However, as is shown above, in 1987 moulding boxes for moulding foundries and moulds 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 IV. 3-18 Main Export and Import Destinations and Origins of Hong Kong Moulds 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 moulds, 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.

2) Imports of moulds 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 IV. 3-17)

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 moulds 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 IV. 3-18)

In the case of metal boxes for foundries and moulds 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 IV. 3-19 Main Export and Import Destinations and Origins of Hong Kong Moulds 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)100.0	

Source: Customs Statistics.

3) Over the past 3 years, the balance of trade for moulds 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 moulds and dies.

(3) Industries Using Moulds and Dies

Industries which use moulds 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 IV. 3-20 Summary of Mould 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

(4) Technology

1) Although in the past manufacturers of moulds 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.

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

(5) Government Assistance Policies

Organizations which provide assistance in relation to moulds 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 moulds 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 Centre

The Kowloon Training Centre, established in 1986, includes a plastic industry training centre and a precision processing training centre. Both centres 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 IV. 3-21.

Table IV. 3-21
Courses Offered by Training Centres

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

3-4 Singapore Mould and Die Industry

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

(1) Industry Characteristics

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

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 moulds.

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

(2) Production and Trade

1) Production

Although there are no statistics on mould 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 IV. 3-22)

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 IV. 3-23) Moulds used in metal casting manufacture, excepting casting moulds, 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 IV. 3-22 Imports and Exports of Moulds 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. Moulds for Metal Foundry etc Excluding Ingot Moulds (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 (CCCN695413)	38,530	39,297	2.0	46,978	19.5	61,524	31.0
	2. Moulds for Metal Foundry etc Excluding Ingot Moulds (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 IV. 3-23 Main Export and Import Destinations and Origins of Singapore Moulds 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-clearance Statistics

Table IV. 3-24 Main Export and Import Destinations and Origins of Singapore Moulds 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

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%). Moulds used in metal casting, with the exception of casting moulds, came from Japan (62.0% of total), Malaysia (9.6%), the United States (9.0%), and Taiwan (5.8%).

(3) Technology

1) Even though the number of employees engaged in the area of moulds 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 mould 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 mould and die technology. These centers have been established with the cooperation of large overseas companies. The majority of managers of mould and die companies and production technology experts have been graduates of these training centres. Details about the centers are listed below:

1) Tata Government Training Centre was established in July 1972 with the cooperation of the Indian company Tata/Telco.

2) Brown Boveri Government Training Centre 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.

3) Philips Government Training Centre 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 IV. 3-25 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

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] mould and die tools; and [8] precision engineering.

The performance of the training centers to data are shown in Table IV. 3-26.

Table IV. 3-26 No. of Students in EDB Mould 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

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

1) 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 mould and die design.

2) 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.

3) 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 mould and die industry, they are often used by the industry which is a 'peripheral industry' and which has many medium- and small-scale companies.

1) Special assistance for peripheral industries (including moulds 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".

2) 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.

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

4) 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.

(5) Problems Facing the Industry

1) There is a shortage of information on mould and die technology. There is also very little information from overseas on moulds 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.