1-5. Mold and Die Workers and Skilled Workers

There are no statistical data which show the total number of workers involved in the Thai mold and die industry. According to MIDI's 1987 survey, there were 869 workers employed in 58 companies located in and around Bangkok. The survey team was able to ascertain that there were a total of 1,112 workers involved in mold and die production in 32 companies (this includes 1 Thai company which has a mold in-house division which employs 300 workers).

Thai mold and die companies are concentrated in and around Bangkok and 330 companies were registered by the Ministry of Industry (MOI) in 1985. Therefore, on the basis of MIDI's survey findings, it can be estimated that there are in excess of 5,000 workers who are directly involved in mold and die manufacture. By taking away the numbers involved in design and indirectly related divisions from the total number of workers arrived at by the survey team, and also taking into account the scale of companies interviewed, it can be estimated that there are between 6,600 and 8,600 workers involved in the manufacture of molds and dies.

In general, because workers employed by Thai mold and die companies are paid daily, and they do not stay with one employer long, so in many cases it is difficult for the employer himself to provide accurate figures. It was said by the Thai side that Thai government surveys are viewed with a high degree of wariness and there is a strong tendency to report fewer worker numbers than there actually are. It is therefore thought that, including the small workshops which were excluded from the survey, there are around 8,000 employees, a figure which is quite near the survey team's estimate.

Although the number of mold and die workers employed by Thai mold and die companies has been estimated at around 8,000, it is impossible to determine the proportions of that number comprised by general workers and skilled workers.

MIDI's 1987 survey shows that 16.7% of the companies had been involved in mold and die manufacture for more than 20 years, and 55% for more than 10 years. This shows that a minimum period of time has passed allowing for them to acquire a certain technical level (Table II-1).

But in contrast to this, 74.6% of workers had had less than 5 years' experience in mold and die manufacture, with 35.6% having less than 2 years' experience. This shows that 1 in every 3 workers only has 2 years' service (Table II-7).

Included among these statistics, 13.6% of workers are from technical institutes or technical colleges, and though it is small, the ratio of staff with tertiary qualifications is increasing.

Viewed from a different perspective, the period of service of workers has become longer, but only by a little, than shown in the above figures.

It is said within the Japanese mold and die industry that it takes 10 years to become a mold worker who can work alone, and it takes much longer than that before one is recognized as a skilled worker.

From the above it will be realized that a large gap exists between Thailand and advanced countries (which include Japan) in regard to mold manufacturing technology. Thus, although in Thailand the skills of general mold and die workers are being raised, it is natural to conclude that with a few exceptions there are few, if any, skilled workers in Thailand. This is also supported by comments made by Thai companies involved in mold manufacture and also by user companies of the mold.

1-6. Present Management

1-6-1. Management Attitude

The present management attitude of Thai mold and die manufacturers is generally one which is positive about the present situation. However, as will be described below, some specific differences were noted from company to company.

(1) Large Companies with Mold In-House Production Divisions

Because there are few manufacturers outside which can satisfy product quality requirements for high and medium grade products, they have adopted a basic management policy of manufacturing molds in-house as a means of guaranteeing mass production and the quality of their own products.

(2) Medium and Small Companies with Mold and Die In-House Production Divisions

The basic management policy of these companies is to take orders which range from mold and die manufacture to the manufacture of plastic molding products and pressed products. Although there are some which only take orders for molds and dies, they make up a small proportion of the total. The main objective is for the mold and die divisions of these companies to manufacture molds for their own plastic molding and pressed products. Therefore they do not put much effort into obtaining orders for molds and dies.

(3) Companies Specializing in the Manufacture of High and Medium Grade Molds and Dies and Parts for Molds and Dies

Many of these companies' customers are large foreign companies or high-grade Thai companies. Requests from their customers mainly center on quality and delivery. In order to raise quality to meet the demands of their customers, the introduction of expensive plant and equipment is essential, and this requires capital investment in the medium and long term. It is necessary to secure steady customers in the future to be able to recover that capital investment. The managers of these companies understand this and plan reforms and expansions for their companies as part of a medium-to long-term outlook. Consequently, they make constructive efforts to expand volume by contacting old and new customers. Because at present there are only a few companies which are like this, they receive a large number of orders and so take a strong position in relation to negotiations concerning the setting of prices and delivery.

(4) Other Medium and Small Companies Manufacturing Molds and Dies

An overwhelming proportion of these companies are run by just one man who sees to all of the company's activities such as sales, decision of specifications, production processes and handling of the accounts. Most of these companies have had dealings with their customers for some time. As a result, they do not make an effort to receive inquiries from prospective customers, but tend to wait for customers to contact them. They are mainly only expected to produce at low prices and so not much is expected of them as far as quality improvement is concerned.

1-6-2. Investment in Plant and Equipment and Raising Funds

Because the large companies with in-house production divisions manufacture molds which are consistently high in precision, they are investing in plants and equipment. However, because their costs are increasing as a result of the accompanying burden of depreciation expenses and expenses needed to instruct and train technical experts, in the short term they are faced with the problem of not necessarily being on top in relation to costs. Nevertheless, funds are supplied from a variety of sources and the situation does not require any particular concern.

The management quality of some of the manufacturers of medium and high grade molds and dies and specialist manufacturers of mold and die parts is relatively good. In particular, the profits of the specialist manufacturers have of mold and die parts been increasing year by year. As a result, steady investment in plants and equipment has corresponded to increases in orders, profits, and meeting the needs of customers. This raises the level of confidence in these companies and loans from commercial banks are used to fund new plants and equipment. However, it is assumed that in order to make significantly greater expansions, larger supplies of funds with favorable lending conditions will become necessary in the long term.

The general situation of recent mold and die manufacture also applies to the other medium and small-scale companies, and though they have begun to make forward-looking investment in plants and equipment, there are many which are aware of no more than the immediate importance of the introduction of plants and equipment. Though as a rule, they depend on their own funds for investment, there are many which complain of the difficulty of raising funds. This is because it is difficult for them to obtain loans from commercial banks due to insufficient collateral or lack of confidence. There is concern that because these medium and small companies mainly use their own funds for investment in plant and equipment, the subsequent restrictions in the scale of investment will slow down the pace of expansion of these companies.

1-6-3. Employment Situation

In some of the Japanese affiliated companies and the large Thai companies the situation for keeping mold and die workers is favorable, and technology and skills are starting to be accumulated within the companies. The companies are making special efforts which include training staff overseas, paying attention to employing workers with special skills, introducing technical instructors, raising technology and skills related to quality control activities, and holding on to mold and die workers. However, because of a shortage of skilled mold and die workers, some companies are beginning to entice workers away from other companies and competition to entice workers has intensified among the large companies. Furthermore, as capable workers are being taken from medium and small scale companies attention needs to be paid to employment trends.

Medium-scale companies are managing to secure the required number of mold and die workers. However, there is a considerable outflow of mold and die workers from companies producing molds for low quality products: they quit their jobs if too many demands are made on them, and highly skilled mold and die workers often set up their own businesses. This low rate of workers staying at one job makes it difficult for companies to acquire their own technology and skills. Also, even if the companies introduce the latest in equipment, there remains the problem of keeping or training workers who are able to use such equipment.

1-6-4. Staff Education

With the exception of the large companies and some medium and small companies which take a positive attitude towards management, the general attitude towards staff training and education is negative. At the bottom of this lies the fear that if one trains mold and die workers they will only shift to another company which can offer better conditions or they will set up on their own company. This attitude, however, is not restricted to Thailand, but is something shared by all mold and die manufacturing countries. Although there are some companies which approve of participation in management seminars and technical training courses held at night, they are negative when it comes to courses which are held in the day time. Furthermore, the negative attitudes toward joining in management seminars and technical training courses which the government sets up is remarkable. There is, though, a high degree of interest in the provision of direct technical guidance from overseas at their own factories.

1-6-5. Cost Structure and Cost Elements in Mold and Dies

(1) Cost Structure

The Thai system of cost control tends to be centered around gross profits . Prices are not set on the basis of modern cost analysis, and there doesn't seem to be an awareness of the necessity for cost control. The interview survey found that on average the gross profit ratio accounted for 20% of total costs, and there were even some companies where this was 40% of costs.

A general comparison of Japanese and Thai cost structures based on the survey is provided below:

	Thailand (%)	Japan (%)
Materials and parts	20-25	20
Labor costs	35-40	50-55
Other expenses	20 [*]	20-30 [**]
Profit	20	

Notes: 1. All values are approximate
2. [*] does not include depreciation
3. [**] includes depreciation of 5% on average

Although it is difficult to make a comparison of the costs of the molds and dies themselves, in Thailand the cost of generally used molds is a half to one-fifth of that in Japan. A newly-established Japanese joint-venture company in Thailand has estimated that with the man-hours of mold manufacture workers at 1.5 times that of Japan and construction costs at half, but with the burden of heavy depreciation expenses today, the total cost is two times that in Japan.

(2) Proportion of Material Expenses in Manufacturing Cost

According to the interview-survey, the ratio of the manufacturing cost comprised by the cost of materials for Thai mold and die companies and related companies was briefly grasped as shown below. It should be noted, however, that the Thai companies do not usually associate the depreciation of equipment, interest or inventory assets with the prime cost.

Companies making generally used molds	30% [*]
Companies making molds for use in IC parts	20%
Companies making standard mold and die parts	50-60%

Notes: 1. [*] The ratio tends to be somewhat higher for companies making press molds than for those making plastic molds
2. All values are approximate

In the case of Japanese mold and die manufacturers, based on survey data collected by the Medium and Small Enterprise cooperation Agency in 1985, materials comprise between 20-25% of the manufacturing cost.

(3) Ratio of Manufacturing Processes

Broadly speaking the processes for molds and dies can be divided into the design, machine processing and finishing off processes. There is a considerable difference in the way Thai mold and die companies handle design, and it is therefore difficult to know what proportion of total processes it accounts for.

For many of the companies included in the interview survey the ratio for the machine processing and finishing processes was approximately 40:60 or 50:50. According to Japanese data taken from the Medium and Small Enterprise Research Center's 1979 report ("Structural Analysis of the Mold and Die Industry") the ratio for machine processing and finishing ranged between 30:70 to 40:60, showing that the finishing process accounted for considerably more than the machining process. This is quite close to the present situation in Thailand. According to JETRO's 1987 "Mold and Die Industry Contends with Endaka", for large molds and those which require curved surface processing technology such as press molds for the outside plates of automobiles and plastic molds for outside frames of OA machinery, design comprises 10%, machine processing 45-50%, and finishing 40-45%. In the case of precision molds for electronics-related parts, the ratio is design 10%, machine processing 60-70%, and finishing 20-30%. Both of these show that a change has occurred in Japan, whereby the ratio for machine processing has become larger than that for finishing.

(4) Methods for Making Estimates

In Japan, for estimates of the price of molds and dies, the cost of each separate process of design, machine processing and finishing, which are based on the type of mold, quality, required precision and the condition of each piece of equipment, are added together to arrive at the cost of materials and expected profit. Because of this, detailed criteria for estimates have been set for each process and each piece of machinery and equipment, and regular annual amendments are made which include the situation of the market and price increases, etc.

However, this method is extremely complicated and therefore medium and small companies, which make up most of the companies in the industry, use a method which has been simplified to the following:

Price = material costs + (charge per unit time x no. of workers)

The charge per unit time = (total costs - material costs + expected profit) ÷ total annual working hours of employees

Whichever method is used, it is necessary to arrive at a unit price for the ordered mold by using data for design, machine processing and finishing. At the same time, it is necessary to have as accurate data as possible for estimating the required man-hours for each manufacturing processes.

Because most of the Thai mold and die companies do not follow the practice of making calculations on the basis of accumulated statistics, the price is determined by the managers' own calculations. Labor costs are lower in Thailand than they are in Japan, but although the industry is one with a high added value there is a marked difference in the necessary man-hour in manufacturing. What is more, there is a high proportion of manual work. Therefore, one basic problem at the present time is that there are no daily records kept of employees' actual working hours for each mold made and the numbers of hours each machine tool was operated which should form the basis of information for making estimates.

Also, the non-existence of set criteria and company data for estimates means that there is no objectivity when it comes to price negotiations and setting delivery dates with customers, thus causing obstruction to this process.

1-7. Production and Technical Management

Molds and dies are the most basic and important of metallurgical tools for production and they figure largely in the production activities of the manufacturing industry aimed at mass production. Their precision and structure are of the utmost importance as they determine the quality of the produced goods, productivity and price competitiveness. Therefore, control over production and the wide range of related technologies must be undertaken with the most rigid control used in the machine processing industry.

In order to grasp the situation concerning control in Thai mold and die companies based on the contents and standards for control, a comparison and an analysis have been made, keeping in mind the following points relating to control in Japanese companies:

• The typical individual order production system. It is difficult to include fixed repetitious processes in this system;

• Due to advances in automation and mechanization as a result of the introduction of modern equipment the industry's structure has become capital-intensive. However, there is still an element of manual work;

• Although the skills of skilled workers are in the process of being replaced by revolutionary machinery and equipment, the selection of equipment to carry out processing, remodelling and also the operation of machine tools are still mainly carried out by skilled workers. Also, the know-how and skills of skilled workers are made use of when programming and making data for automated and semi-automated machine tools;

• Although the precision of machine tools governs the basic precision of molds, the top level know-how of engineering experts and the know-how of skilled workers makes it possible to use machine tools to their maximum capacity and creates harmony between man and machine;

• Although the renewal of equipment is relatively fast and investment in plants and equipment is carried out, the rate of equipment operation is low due to the products being single products;

• Because products are single products, workers and their skills are subject to the greatest degree of control. However, there are limitations and, though there are some exceptions, it is not possible to expand the scale of operations.

• Materials account for a low proportion of the total cost (approximately 20%), and the mold and die industry belongs to the group of industries within the manufacturing industry which has the highest ratio of added value. Because of this it is well recognized that the accumulation of improvements to control and the efficient control of the balance between worker and equipment directly related to production is more important than in other industries in relation to productivity, quality and profits which affect a company's ability to maintain or strengthen its position;

• True CAD/CAM is needed in order to raise productivity and increase added value. This requires that a large volume of data be acquired from now on and it also requires the renewal of equipment. Because this in turn requires large-scale investment and much time there are varying opinions within the industry about the use of CAD/CAM.

1-7-1. Design

(1) Recognizing the Importance of Design

Although molds and dies are only a tool or part of a production process for producing mass produced finished goods, they directly affect the productivity and quality of products and their importance is the same as, or higher than that of, product planning. The design of molds and dies is the end product of a process of taking into account costs, quality, and delivery, and these relate to the various specialist areas of companies which produce finished products by assembling parts manufactured by using molds, companies which use molds directly to produce parts, and also companies which manufacture the molds themselves. It is only natural that the role of adjusting these components must be carried out by the mold and die manufacturers who know the limits of their capacity to manufacture molds. Nevertheless, many of the mold and die manufacturers in Thailand do not consult or confirm with the companies placing orders concerning their own capacity to meet requirements regarding the purpose for the order, productivity, and the molding capacity (plasticity) of the parts manufacturers. Instead, they set the cost and decide on delivery on the basis of a model or plan made by somebody else, and then suddenly launch into manufacture. As this shows, there is hardly anybody who recognizes that design is a comprehensive engineering task which is the starting point for production.

(2) Review of Plans

In cases where the mold manufacturer has to work on the mold plan subsequent to the product plan it is not usual practice to seek the confirmation and approval of the user of the mold for each important step in design. A assemble plan greatly influences the processing cost of molds, and for the user, the construction of the mold has much bearing on the quality, and production cost of products. through of this, the intentions of both the supplier and the user of the mold are always coordinated, and it is by these means that a good mold is produced. It is necessary to understand that plans are the means for achieving this. In an extreme example which was encountered during the interview process, it was reported that as a result of a mistake concerning the one dimensional method and the three dimensional method for drawing diagrams it was discovered after the completion of a certain mold that the mold was completely useless.

(3)Management Attitude Towards Design Technology

It is design capability which forms the basis of a mold's quality and productivity. An increase in the number and the quality of designers with engineering knowledge is a top priority task for the development of the Thai mold and die industry. Even though the importance of this may be recognized there is a danger that, being content with the present favorable situation, management takes a negative attitude towards future investment aimed at improving design capability. It is necessary to take note of the precedent set in South Korea and Taiwan where, though they are fast catching up to mold-producing advanced countries, the problem of fostering and maintaining real designers is their greatest shortcoming.

(4) Acquirement of Design Technology

A wide range of engineering knowledge gained through schooling is of considerable importance for people who work as designers. Nevertheless, though this sort of knowledge is useful, it is not something which directly produces designers. When it comes down to it, design is something that is learnt through understanding how each company's design instructions which cover the accumulation of separate processes of design and how the processing technology criteria which corresponds to the company's equipment are applied to the various objects of design. The present situation in which such company criteria, are neither systematized nor available, but yet necessary and important for developing elementary design capability, hinders the fostering of designers within companies.

1-7-2. Equipment Planning

(1) Planning Trends

According to MIDI's 1987 survey, the number of companies which did not carry out planning of equipment accounted for 31.7% of the total. This is, though, a significant decrease from the 46.7% recorded at the time of 1983 survey, and it shows that positive steps are being taken to improve the industry's environment by increasing and improving equipment. Instead of the previous trend where there was a concentration on the introduction of EDM, W/C EDM, a change over is taking place to profile milling machines and grinders whereby equipment with NC functions are starting to be sought.

This shows that the industry as a whole understands what sort of equipment and combinations of equipment are necessary to maintain product standards above a certain level. This is a desirable step towards the planning of balanced equipment.

(2) Trend towards High Grade Equipment

There is a strong tendency to introduce high grade equipment such as machine tools with NC functions, machining centers, and full-scale CAD/CAM systems. Although in terms of the future this trend is in itself a favorable one, there are many problems involved. These include the requirement of costly investment and the necessity of accumulating data and standardizing criteria concerning many aspects such as design, processing and control in order to be able to use such equipment properly and effectively.

(3) Overemphasis on Machine Tools

It was felt that in relation to the introduction of equipment, an overemphasis was placed on machine tools and CAD/CAM systems. There was, however, a very low level of interest in inspection and measurement tools and equipment which are essential to the introduction of high grade machine tools now and in the future. (There were a number of examples where three-dimensional measuring instruments were suddenly mentioned by companies during the interviews.) Also, hardly any interest was expressed in machining, grinding and polishing tools.

(4) Renewal of Old Equipment

Receiving the most interest is the renewal of old equipment in order to raise precision levels and processing capacity, though there was some variation in the extent of interest according to the age of equipment.

(5) Passiveness

While the planning of equipment should naturally be taken seriously became a large amount of investment is required for the company, mold and die companies everywhere basically take a passive attitude when it comes to expanding business. Nevertheless, they are positive about improving technology, raising quality and improving their capacity for production, and (1) to (4) above can be applied to such companies.

However, a number of companies which were visited in the course of the interview survey did not feel the necessity for improving the standards of their companies, and they had no interest whatsoever in their own equipment. As the back ground reasons for the positive attitude forwards the present situation by such operators, there is the fact that the domestic market for imitation goods is on booming, and demand from a brisk imitation market support the company operators sufficiently. This point is worthy of note.

1-7-3. Production Stages

With the exception of foreign companies and some of the large-scale Thai companies, there is little sign that production management, as it is known in its general sense, is being carried out. This is clear from the absence of basic data and written criteria covering the control of production methods, processes, and the level of workmanship. The situation is one in which the many individual company operators depend upon their own instincts as a means for achieving production management. Also, there were more than a few cases where the significance of production management itself was not understood.

The fundamental problems which were revealed through the interview survey are listed below:

• In general, there is no custom of making numerical calculations concerning the processing scale and the making of production schedules for each type of mold.

• In relation to orders, cost calculations, suitability of processing, and estimates for delivery dates are not properly carried out.

• At the time of manufacture it is not possible to set a work volumes for workers, the order for work and manufacturing, or the production process, and plans for a production schedule cannot be made for both in brief or in detail.

• Therefore, orders cannot be accepted systematically to correspond with the company's processing capacity, and in response to questions all the companies said that delivery was left unchecked and delays to delivery were common.

• There were hardly any cases where a standard number of working hours was set for each individual process. There are no records of past performances which should form the basis of such calculations.

• Instructions given to workers concerning work are mainly verbal and are abstract. This means that it is not possible to gauge work progress and efficiency.

• There are many cases where the raw material suppliers and heat treatment company operators are uncertain as to the requirements of the order (purpose, materials, required hardness), and it was also said that there was no planned timing in placing orders.

• For companies which handle mold or die parts or those which specialize in just some processing stages, it is easy to make plans for processing in relation to the product's characteristics. What is more, and it may be due to the high educational level of such company managers, the plants are run along modern control methods and there are no real problems.

• Generally, medium and small-sized companies undertake all the stages of manufacturing in-house and do not follow the concept of division of labor. This is one reason why it is not possible to raise the level of technical expertise and quality for various branches of mold and die production technology, and also shorten delivery time.

As seen above the problems relating to processes ultimately affect the delivery of molds and dies. Although it is not possible to make a formal comparisons due to a lack of data, according to one Japanese affiliated company, even if a mold plan is supplied for a one-off conventional mold, an experienced company will take as much as 2-4 times the amount of time which is required in Japan. It was also reported that there was a company which took eight times as much time.

The standard delivery time in Japan is within one month of order for a one-off precision mold and about eight months after order for a total set of transfer molds for automobile panels. But now users are requesting that delivery time be shortened. At the present time when the life cycle of products all around the world is being shortened, whether or not Thai mold and die manufacturers can shorten and meet delivery dates is something which is of vital concern to the producers of manufactured goods for export. An important element in this is whether rigid manufacturing processes for molds can be set and whether effective control can be carried out.

1-7-4. Quality Control

(1) The Concept of Quality Control for Thai Mold and Die Manufacturers

Quality control for mold and die manufacturers is something which takes into account and checks the maintenance of set conditions and criteria which have been established for the individual processes which are required for making molds economically while at the same time maintaining the required quality of the molds to meet the manufacturing quality required by the customer. In the broad sense of the term, what is necessary for such quality control is the control of design, materials, and processing methods and standards. But in the narrow sense of the term, it is the control of processing methods and standards for making molds which are of a quality that meets the specification decided at design stage and the required mold form.

In this sense, despite the difference in scale between big and small companies, Thai mold manufacturing companies do not carry out proper quality control. The majority of companies are under the mistaken impression that quality control is the act of inspecting general dimensional measurements and the out-view of finishing.

(2) Quality Control Supervisors

The larger the size of Thai mold and die companies, though only marginally so, the greater the ratio of supervisors whose job is just quality control. However, they basically do not go any further than guaranteeing rudimentary quality through mainly inspections in the ultimate stage of manufacturing.

(3) Basic Steps for Quality Control

1) Quality Standards and Criteria

The starting point for quality control is for everybody to share the same criteria for making decisions which correspond with a company's technical level and the improvement of that level. The quality of the mold itself is the accumulation of the processing quality of the processing carried out in the individual processing stages. Therefore, the minimum requirements for this are to provide manufacturing quality standards relating to materials, structure, dimension accuracy, and finishing and processing technical standards which stipulate a rigid order to be fulfilled during the processing, and to put them in place along with a thorough familiarity with their contents and their implementation. Even though when visiting Thai companies catalogs of foreign products (parts) and some technical manuals were spotted, there was no sign of anything which would be sufficient to be called implementation of quality control.

2) Machinery and Tools for Use in Inspection

An important part of quality is the checking of the standard of quality through inspection. Only a very few capable skilled technicians and skilled workers are able to determine quality by sight and touch, and basically, instruments and tools are required for inspection. The various measuring tools of each company which were included in MIDI's 1987 survey are as listed in Table II-11, and these include basic measuring tools such as slide calipers and micrometers.

However, the situation concerning the control and storage of these measuring instruments is nearly the worst possible, and they are treated just as if they were general tools. Also, there was no evidence that regular retesting was undertaken using primary standard gauges to check that the accuracy of these instruments was being maintained. This suggests an extremely serious problem all the more serious because molds are manufacturing products for which precision is of the upmost importance.

If the Thai mold and die industry is to manufacture molds of a higher standard than the current standard, something has to be done about the measuring tools that it possesses which have already reached their limits. As clearly shown by MIDI's 1987 survey, though many general Thai mold and die companies show strong interest in the introduction of the latest in machine tools, there is very little interest shown in inspection equipment such as testing machines and measuring machines. Even concerning such inspection equipment, there is a tendency to be interested in those which take measurements and interest does not extend to testing materials or testing the wear of cutters or the condition of processing surfaces.

(4) Feedback on the Results of Quality Control

The reasons for carrying out quality control are to reduce the production costs of molds and to maintain and improve quality. Therefore, it is imperative to return to the starting point and think of new measures for matters requiring improvements and for readjusting irregularities which have been discovered in the control process. In such cases it is normal to return to the various stages, including design, processing and procurement, and take new measures. Questions which should be asked are:

• Why weren't centering, perfect circles and the degree of parallelism accurate? Why didn't surface luster show? Why were there scratches from cutting tools? Why wasn't the delivery date met? Why was the life of the mold short?

• Why were there flashes and discoloration in plastic molding parts? Why was separation from the molds bad?

• Why were there cracks and creases on pressed parts? Why was there a lot of warping and compression?

However, the real situation in Thailand is such that there are many cases where quality is only checked simply on the spot, or decisions concerning quality are left completely up to the users of the molds. Companies do not make efforts to search for the reasons for bad quality themselves, nor do they leave records or go through the problem with those involved or make improvements. An important key to the accumulation and improvement of technology is the repetition of this sort of feedback, and it is necessary to realize that carrying this out is the source of advancing technology and skills.

1-7-5. Safety Control

In general, the in-house production divisions of foreign companies and large Thai companies pay attention to safety. However, in the case of many Thai companies there is no one who is in charge of safety. Furthermore, education concerning safety and keeping the work place in good order by such means as posting attention-catching slogans is not carried out to the extent to which it is by Japanese affiliated companies.

There is a tendency for there to be more problems directly related to the work environment and safety the smaller the size of the company. Some basic examples concerning safety which were encountered in the course of the survey are listed below:

• Although some companies were seen to use optical safety devices to protect workers from machines, generally workers were extremely unprotected from machines. At best, press machines were fitted with manual emergency stop buttons (protection for the human body).

• Safety covers were not used for belts or revolving parts (protection against entanglement).

• There were bare high voltage electric cables indoors, many loads were put on one electrical outlet and electric wires from it laid on the floor with no protective covers (protection against electric shocks, prevention of abnormal stoppages of electrically powered machinery and equipment and prevention of short circuiting).

• Workers below places where heavy objects were being hoisted (protection of human body).

• Lifting and carrying of heavy items wearing sandals (safety shoes, protection against injury).

• Handling of rotating machinery especially for lathes, with a gloved hand(protection against injury by entanglement).

• No use of protective glasses to prevent dust getting in the eye during cutting, grinding and polishing (health control, protection against injury).

• Implements not put in good order, no set passageways- safety routes (eliminating possibility of accident or fire).

• Loose mesh protective covers for high powered fan outlets (protection of human body).

• Pregnant women operating heavy machinery (protection of mother's body).

1-7-6. Supply

(1) Materials

The materials which are generally used for molds and dies are listed in Table II-14 taken from MIDI's 1987 survey. The findings of the interview-survey are similar to MIDI's results. The most common materials are high carbon steel S50&55C and general structural steel SS41. These are followed by tool steel SK3&5 and SKD11&61. Others include ductile cast iron FCD30&50 and preharden steel PDS5, which are beginning to be used along with the increase in EDM processing. Little nonferrous alloy steels, special alloy steel, high speed steel SKH, or stainless steel SUS are used.

The bulk of materials are imported from Japan, while some are imported from western European countries such as Sweden.

(2) Obtaining materials

With the exception of cast iron, because imports are depended upon for materials there are few varieties, and though it is possible to obtain the SS, SC, SK, SKD grade of materials shown above immediately, other grades and special types of material require a certain amount of time. In some cases it takes more than 2 months. Also, because there are few stocks of large-sized materials, these also require a long period of time to supply.

(3) Price

For the supply of materials, the required amount for each order is purchased when the order is received. Therefore, because the size of the orders is small there are remainders and according to material suppliers the delivery price for mold and die manufacturers is comparatively expensive.

(4) Use of materials

The mold and die manufacturers generally have little knowledge about metal materials and they usually buy materials, in accordance with instructions given by the customer. However, in many such cases only the type of material is specified and not the grade, thus frequently causing trouble between the material supplier, the mold and die manufacturers, the heat treatment and the plating company, and the user of the mold.

(5) Others

For electrodes for EDM use, copper electrodes are used in most cases and they are easy to obtain. Although the use of electro-forming electrodes is increasing, carbon electrodes are still not used very much at all. There is, however, no problem in obtaining electrodes for use in wire cutting.

Because there is a heavy reliance on imports for cutting, grinding and polishing tools, there are still restrictions in the types available, prices are expensive, and they are not easy to get hold of. The situation tends to be the same for good quality general metallurgical tools, and it is especially difficult to obtain files and buffing materials.

There are some Japanese companies in Thailand which point out that because of the problems related to the price and availability of materials and tools, the manufacture of these products in Thailand is a priority task for the future.

Table II-14. Types of Metal used in Producing Molds

	Type of Metal	1983 Sites	1983 %	1987 Sites	1987 %
1.	Scrap Iron	–	–	–	–
2.	Mild Steel	43	71.7	47	78.3
3.	High Carbon Steel or Alloy	48	80.0	40	66.7
4.	Tool Steel	24	48.3	28	46.7
5.	Stainless Steel	9	15	–	–
6.	Mixture of Aluminum Copper or Zinc	4	6.7	3	5.0
7.	Others	–	–	4	6.7

Notes: % means percentage among all factories surveyed.

Sites mean the unit factories.

1-8. Standards for Mold and Die Manufacturers

As has already been mentioned, whether or not manufactured products can be made using methods which meet internationally accepted standards depends on technical standards and decisions concerning product quality. What is required in order to be able to keep pace with such standards is the establishment of national or industry level standards. Companies should maintain official standards or seek even higher standards and establish, implement and oversee detailed standards covering all manner of aspects in line with each company's own particular situation.

The general industrial standards of each country cover most standards relating to molds and dies, and in the case of Japan the Japanese Industrial Standards contain standards which have been set specifically for mold and die parts. Also, West Germany's industrial standards (DIN) include examples of plans for molds and dies. Although Thailand has established some industrial standards, TIS (Thailand Industrial Standards), on the basis of the JIS, the standards are still inadequate and there are some who would like to see the establishment of a system of industrial standards which, as well as containing general machine processing standards, contain details for industrial standards pertaining specifically to molds and dies and also inspection and testing methods.

A company's own standards tend to be established as the result of a steady accumulation of experience and know-how over many years. It would seem that the time has not yet come for the majority of Thai mold and die manufacturers. Where companies showed us their standards, the contents were exactly the same as product catalogs from specific foreign companies, especially Japanese, and the standards were limited to the criteria for material selection, dimension maintenance, and hardness shown in the catalogs. No interest was expressed in aspects which have a strong bearing on quality such as waviness, deflection or surface roughness. Instructions to outside contractors (sub-contractors) were also limited to the catalogs. However, among medium-sized mold and die part manufacturers there were some which sought levels which were higher than machine processing precision standards based on the JIS, reflecting the emergence of a correct perception of required technical levels.

1-9. Supporting Industries

1-9-1. Heat Treatment

The situation of heat treatment specialist companies related to the mold and die industry as perceived during this survey is described below, with specific details having been taken from a report on the Thai heat treatment industry produced by the Industry Research Center of the Department of Industry Promotion in Thailand in 1984.

(1) Situation of companies

Companies have prospered along with the development of industry in Thailand. It is estimated that the number of companies entering the industry is increasing. Company profits are easily guaranteed and the average wage of employees is put at more than 20% higher than that of mold and die industry workers. The methods for heat treatment mainly used are annealing, hardening and tempering, and cementation and nitration are also commonly carried out. As for equipment, electric heating furnaces are the most used, followed by a large number of heavy oil heating furnaces. Gas heating furnaces are on the increase. The largest furnaces, which measure 80cm in diameter with a height of 100cm and reach up to 1,100 degrees Celsius, are commonly used in Thailand. As future equipment, vacuum furnaces are required in order to increase heating capacity.

(2) Problems relating to Heat Treatment

When orders are received from mold and die companies, only specifications as to material and the degree of hardness are given, and there are cases where instead of advising hardness requirements, only the use of the mold is specified. Many mistakes are made over the specification of supplied materials and as a result, although some checks are made by carrying out spark tests and preliminary trialsuring samples, there are many cases in which the required hardness is not obtained and cracks appear, etc. One of the reasons for this is the use of cheap materials in order to keep costs down at the expense of heat treatment.

There are a number of problems relating to heat treatment companies. One is that records are not kept for temperature control which is the most important aspect of heat treatment. There are factors determining hardness which are used to check quality, but no means for checking the composition of materials, depth of hardening and hair cracks. Also, there are no shot blasters or surface grinders which are pieces of equipment required for the finishing process after heat treatment has been completed.

There are many complaints from mold and die companies about the bad quality of heat treatment. They include complaints about insufficient hardness after hardening, unevenness in hardness, deformation, and surface deterioration.

1-9-2. Surface Treatment

The surface treatments for molds and dies adopt in general such methods as the following : Electro chemical processing which is carried out on the cavity surfaces of molds in order to stain the surface of products to aventurine flesh; electro plating (hard chrome plating) on the surfaces of mold cavities to bring out the shine and luster of products, and, in particular, to increase the transparency of transparent plastic molding products while maintaining the degree of roughness and improving the durability of cavity surfaces of molds; and anti-corrosive coating by means of phosphate coating treatment which is usually carried out to strengthen the coating of mold parts, particularly that of major movable parts.

Judging from the observations by the survey team on the conditions of molds and products manufactured from molds, the technique used for electro chemical processing is of a reasonable standard for market products, and there is no problem with the technique for phosphate coating itself, although some mistakes were seen, such as caring out coating treatment on coating parts of molds, something which affects heat conductivity.

In the case of Thailand, because very few products are manufactured by mold, the electro chrome plating technique has hardly found its way into the whole mold and die industry. However, the steady demands are gradually being made, and the necessity for this in the world of mold and die shall rise rapidly from now on along with the development of other industrial areas in Thailand.

The following points are outlined by survey team as the problems of Thai electro chrome plating industry.

• A Japanese affiliated specialist company in Thailand was only equipped with the plating facility to treat a large part.

• The control of plating processing is poor in general. In particular, there is no company able to inspect and analyze the electrolyte in-house with the result that the plating companies always leave the management of the electrolyte in the chemical suppliers' hands. When sampling the electrolyte from the plating bath, the chemical composition and the temperature of the solution sampled become ununiform because of insufficient mixing before sampling. This gives values widely different from the actual values for the results of analysis of major components, content of impurities, and solution freshness.

Furthermore, the plating treatment is carried out with no special attention to washing the mold surfaces and is completed with chips and dusts still on the plating surfaces.

The control of electric current density is also in adequate.

• As almost all of the chemicals for plating processes depends on the import market, there are opinions that the cost of the plating cost is set by cheaper labor cost used due to the expensive price of the imported chemicals. Receiving the chemicals takes a long time, and sometimes it is impossible because of sudden changes in import restrictions such as toxicant restriction.

• Although buffing on mold surfaces is required to be carried out prior to commencement of plating process in order to maintain the quality of the plating of buffing. Also the buff material is not available from the domestic market.

On the other hand, there are many complaints from electro plating companies concerning mold and die manufacturers as referred below.

•The surface conditions of the molds and dies put burdens on the ability to form the product. Improvement of the skill the workers in charge of final finishing is necessary.

• The countermeasures for mold local touch does not to the skill and the know-how of skilled workers. In particular, for the mold stick, which is frequently comes up, due knowledge is not yet required concerning final finishing and mold maintenance using pad welding and burning technique.

• The problems with the pad welding technique, which is indispensable for maintaining repairing molds and dies, are as follow;

Incorrect selection of the welding rods.

Ignorant control of welding rods, particularly no provision of a welding rod dryer.

No custom of edge preparation.

Blow mole after welding.

Check of welding performance by pigging is not carried out.

Because of this, there are many problems such as hair cracks and blow holes due to poor weld penetration, plating film not adhering fast, surface hardness left on the plating surfaces.

Under circumstances, the complaints from electro plating companies show a trend forwards focusing on what skills and know-how the skilled workers in the mold and die manufacturer fundamentally have to possess.

1-10. Obtaining and Exchanging Technical Information

The most representative comments obtained during the process of the interviews are listed below.

- There is a constant lack of information on technology, especially on international technical levels, required quality, trends in technological development, and information and purchasing methods relating to the newest machine tools, measuring equipment and instruments, and tools;
- Nothing is known of the mold and die market, or its trends;
- Although the importance of seminars is understood, seminars to date have been too difficult to understand;
- It is not known even within the same manufacturer who is doing what and where, and the exchange of information is restricted to conversations among friends;
- There is no institute directly related to molds and dies, and basic specialist information and trends in academic research are unknown;
- There is no industry organization, and because there are no specialist bulletins the sharing of general information within the industry is difficult;
- It is not known what the industry's, or a particular company's, standing is concerning technology;
- An organization which is privately based would be desirable for the exchange of information and opinions.

1-11. Technical Know How

1-11-1. Precision of Molds and Dies

Needless to say, the accuracy of processing dimensions is the largest factor which influences the quality of molds and dies. In Japan too, every company is continually working to maintain and raise dimension precision, and this also requires costly investment.

The required precision for a mold is determined by the precision which is required of the products which are made using the molds, and moreover, the degree of precision which can be attained precision differs according to the use of the mold, the structure of the mold and its size. To use the case of Japanese plastic molds for injection molding as an example, the precision of the mold's dimensions is based on the required dimension tolerance of the molded products, and tolerance is 20% for whole molds and within 15% for assembly-type molds. These are general target values which are used today. For example, where the dimension tolerance of molded products is +/- 0.3 mm the maximum required precision is:

Whole molds:	0.3 X 0.20 = 0.06 mm
Assembly-type molds:	0.3 X 0.15 = 0.045 mm

However, in practice it is not easy to make molds which have a precision of within +/- 0.05mm.

In the case of W/C EDM, concerning which there is strong interest in Thailand, although the possible nominal processing precision is put at around 1/1,000mm in catalogs, due to the vibration of wire electrodes and molten layers caused by electric sparks, in reality a precision of 1/1,000mm cannot be expected in the electric spark process alone.

In Japan today, the precision of molds and dies which is commercially attainable is around the 2-4/100mm level and it is difficult to attain precision of around 1/100mm (according to the Japan Die and Mold Manufacturers Association). Although some extremely rare and special molds with a precision of 2-3/1000mm are produced, these require very special measurement technology and a special measurement environment. Generally, because in order to check precision of 1/100mm, measuring instruments with a measurement sensitivity of 1/1000mm are required, the standards of processing techniques and industrial precision measurement technology make it very difficult to manufacture molds and dies which have a precision of less than 1/100mm.

The results of MIDI's 1987 survey relating to the accuracy of precision molds and dies made by Thai mold and die companies are shown in Table II-15. According to the

Table II-15. Precision of the Most Precise Mold

	Precision	1983 Sites	1983 %	1987 Sites	1987 %
1.	With Naked Eyes	3	5.0	2	3.3
2.	0.1 MM or More	14	23.3	14	23.3
3.	0.02 - 0.05 MM	14	23.3	16	26.7
4.	0.01MM	20	33.3	11	18.3
5.	>0.01MM	7	11.7	17	28.3
6.	Unable to Answer	2	3.3	–	–

results, roughly half, or 46.6% of companies manufacture molds with an accuracy of less than 0.01mm, and the percentage of companies with a precision of less than 0.05mm, which is the set standard in Japan, is as high as 73.3%.

This varies greatly with the existing international evaluation of Thai mold and die companies, and it also varies from the conclusions of the survey team based on the inspection of machinery and equipment, the working situation, measuring machinery and the tools and the molds themselves at the companies which were visited. A Japanese company which is putting effort into manufacturing molds replied in an interview in Japan that it could only manage a precision of up to 0.02mm on commercial base, which also is at odds with MIDI's survey.

During the course of the interviews in Thailand the reason for this became clear: there were more than a few companies which mistook the sensitivity (smallest reading unit) of measuring instruments, such as micrometers and slide calipers, for the precision levels of completed molds. One reason for this is the general lack of interest and awareness within Thai mold and die companies about the importance of inspection and measurement.

It is clear and has to be asserted that the starting point of this over estimation of mold quality, especially for dimensional accuracy, originated in a serious misunderstand relating to measurement of dimensional accuracy.

For molds which are not very complicated quite a number of Thai companies are of a level where they can maintain a dimension accuracy of somewhere near 5/100mm. Also, one of the Thai companies visited could make molds with a precision level in the 1/1,000 range.

1-11-2. Materials for Molds and Dies

There are many people both within and outside Thailand who mention materials as one of the problems facing the Thai mold and die industry. During the course of the interview survey the users of molds, mold manufacturers and the heat treatment companies all complained of the others' lack of knowledge about materials. From what they said, it is clear that in relation to the use of molds and the desired quality there is little knowledge as to how to select materials balancing cost and the processing properties of molds.

However, this can be attributed in part to the limited range of materials (refer to Procurement) handled by material suppliers, and an inability to obtain suitable materials due to volume and size constraints.

The most common problems which came to the surface concerned the short life of molds, Deformation caused through heat treatment, and the appearance of cracks. There is also the possibility that, in some cases materials which were of a higher quality than required for the purpose of the molds have been used unknowingly.

The basic problems in the selection of materials for molds and dies concern the physical properties of materials relating to the use of the mold, the required life of the mold (number of product shots), how easy it is to process a mold, and related know how. There is also a weakness in the ability to choose the most suitable material on the basis of combinations of such criteria.

That is, an ability is required to make judgements for the selection of materials for each plastic molding mold and press die by placing emphasis on the appropriate factors and combinations of the factors listed below:

- material hardness, thermosetting capacity, and heat deformation capacity,
- anti-abrasiveness, anti-corrosiveness, and anti-impact property, plating capacity,
- cutting and grinding capacity, mirror-like finishing capacity, electro chemical processing working capacity, heat conductiveness, and welding capacity
- strengthen, and toughness.

Among these, mold and die users, manufacturers and heat treatment operators all have a strong interest in ultimate hardness, and this is followed by a strong tendency for mold and die manufacturers to be concerned with a material's cutting properties.

1-11-3. Structure of Molds and Dies

Compared with taking care over the processing of cavities and also the upper and lower

parts of molds, in the manufacture of molds and dies there are many more small problems which directly affect the intensity of molds and product quality. Most of these problems arise as a result of the absence of standardization in the structure of molds and in the positioning of parts.

For example, there are the problems of preventing undercutting, the positioning and number of cooling pipes, gate structure and positioning, and the positioning of other parts. These cause a variation in the thickness of products, discoloration, discolored streaks, creases and warping, and greatly affect the durability, productivity and this can quality of molds and dies.

1-11-4. Processing Methods

In the course of the manufacturing process the most important requisite for maintaining the design quality specified in designs is the suitability of the method used for cutting for each separate process. In other words, the quality of each mold in terms of the required level of quality is the aggregate of the quality levels which have been set for each cutting process. The quality of cutting itself is determined by the capacity of machine tools, the selection and condition of cutting tools and the machine control skills of the operators who work them.

As these depend on on-the-job experience and the perception of operators who are well acquainted with the special characteristic of processing machines in operation, in fact the machining processes progress bored on practical standards which standardize the dimensional accuracy, the degree of surface roughness, and possible machining profiles as per each processing machine. It also depends on the instructions which prescribe the technical arrangement and order to be kept in operator's mind so as to achieve the level of practical standards.

It may be because of the slowness of individual companies to introduce such standardization that some examples of incorrect processing methods were observed within the Thai mold and die industry during the course of the interview survey. The following are examples which were particularly noticeable:

• A lack of understanding as to the limitations in processing concerning possible quality for each machine tool related to diameter, perfect circles, flatness, centering, and surface roughness, and also the use of unsuitable machine tools;

• Incorrect order for machine processing;

• Disorganized manner in processing the machining allowance to be are left for the next processing stage;

• Unsuitability of processing quality levels established for cutting speed, feeding volume, and cutting volume (includes EDM);

• Mistakes in cutting methods used for roughing, semi-finishing and finishing.

2. Market

2-1. Present Status and an Overview of Domestic Demand

In Thailand, demand for molds and dies is increasing each year along with industrial development, which is especially large among the automobile, motorcycle, plastics, and household electrical appliance industries. Since the increase in production and the number of manufacturers is not enough to keep up with demand, imports of molds and dies are also increasing.

2-1-1. The Automobile Industry in Thailand

(1) The Role of the Automobile in Thailand

It is said that the process of motorization begins when the per capita GNP reaches a level of US$2,000. Thailand has not yet arrived at this point, since its 1985 level of per capita GNP was only US$700. Looking just at Bangkok, however, where the per capita GNP level has exceeded US$2,000, it can be said that motorization has begun. This is demonstrated by the fact that 3/4 of the automobiles in Thailand are registered in Bangkok. The high ratio of upper-class wage earners concentrated in Bangkok, such as teachers, shopkeepers, management executives, and high-ranking public officials accounts for most of the customers, although purchases for government offices and by companies cannot be overlooked.

In any case, for the ordinary citizens of Thailand, passenger vehicles are a high-priced durable commodity that is beyond their reach. Although there is a concentration of high-quality vehicles in Bangkok, commercial vehicles like vans and trucks are only 1/3 to 1/2 of the total vehicles registered in Bangkok. The reason is that 2-wheel and 3-wheel vehicles, small trucks, and the like are the main means of transportation in areas with low income levels.

(2) The Start of the Automobile Assembly Industry

It is said that the introduction of the automobile into Thailand occurred around 1900 when a person with connections to the Royal family purchased and brought back a vehicle from the West. Until 1961, domestic demand for automobiles was met by imports of completely manufactured vehicles.

Domestic automobile industry development began in the 1960s along with the policy of import substitution. In 1961, a joint venture, Thai Motor Industry, was set up by Anglo-Thai Motors and British Ford, and the assembly of complete knock-down vehicles began. In 1962, many factories were established in response to the Investment Promotion Act, which centered upon tax incentives, and by the 1960s, there were 11 assembly sites. The number of assembly manufacturers in 1984 is shown in Table II-16.

(3) Automobile Production

Production levels have been fluctuating from 525 vehicles in 1961 to 11,698 in 1969 and 114,000 in 1984, then falling to 85,000 in 1985, and 79,000 in 1986. The number of vehicles produced has been on the decline in recent years. There are 3 reasons for this: first, a lack of capital in the agricultural sector due to depressed export levels and low prices for agricultural products; second, a sharp rise in the price of Japanese cars due to a rise in imported component prices as a result of the appreciation in the value of the yen; and third, an increase in costs due to the high prices of domestically manufactured parts caused by an increase in the local content ratio. The cost of domestically manufactured parts normally exceeds that of imported parts. The ratio of passenger vehicles to commercial vehicles in 1984 was 3 to 7, thus being very different from the ratios of Malaysia and Singapore, where 60 to 70% of the vehicles are for passenger use and only 30 to 40% for commercial use.

The overwhelmingly high percentage of commercial vehicles in Thailand is a reflection of several factors: first, that average income levels in Thailand are not comparable to those in Malaysia or Singapore; second, that import tariffs on knockdown component sets are 112% for passenger vehicles, but only 10 to 72% for commercial vehicles, with the majority being between 10 and 30% in the latter case; and finally, that the business tax is 33% for passenger vehicles, but only 9.9% for commercial vehicles.

Basically, high automobile prices in Thailand result from a structural problem caused by small lot, large variety production and an increase in local content ratio. According to statistics issued by the Ministry of Industry in September 1983, 60 series and 180 models of passenger vehicles were being assembled. For the Toyota Corolla, the most popular passenger vehicle, 7,500 units were produced during 1984, the year of industrial prosperity.

Table II-16. Assemblers in Thailand

Manufacturer	Brand	Breakdown		Monthly	No. assembled in 1984		Year
		Passenger	Commercial	Capacity	Passenger	Commercial	
1. Isuzu Motor	Isuzu	-	100	1,500-1,800	-	21,573	1966
2. Siam Automotive	Datsan	-	100	1,500	-	17,855	1978
3. Toyota Motor Thailand	Toyota	50	50	2,000	11,115	16,763	1964
4. United Development Motor Industry	Mitsubishi	50	50	1,200	3,302	7,042	1964
5. Thai Hino Industry	Hino-Toyota	-	100	800	-	4,502	1967
6. Sukoso & Mazda	Mazda	60	40	800	4,118	2,220	1975
7. Siam Motors & Nissan	Nissan	100	-	600	5,435	-	1963
8. Bangchan General Assembly	Opel , Gemini, Honda Daihatsu, Suzuki, Ford Fuso, Polnet	80	20	400-500	1,780	1,048	1972
9. Karnasuta General Assembly	Fiat, Ford Fuso, Polnet	80	20	400-500	1,090	2,306	1962
10. Y.M.C. Automotive	BMW, Peugeot	90	10	300-400	6,750	11	1973
11. Thonburi Automotive	Mercedes-Benz	50	50	300	1,001	100	1963
12. Prince Motors	Nissan, Subaru, Alfa Romeo	70	30	250	1,012	240	1965
13. Thai Swedish Assembly	Volvo	80	20	250	774	-	1976
14. Siam General	Nissan, Suzuki	-	100	150-250	20	1,250	N.A.

Source: Japanese Chamber of Commerce and Industry in Bangkok, "Chamber Report", September 1985.
EIU "Thei Asian Motor Industry: Problems and Prospects" July 1985.

(4) The Drive Toward an Increase in Local Content Ratio

The history of automobile production in Thailand has been a consistent process of strengthening import substitution by increasing the local content ratio. Looking back on the development of the automobile industry after 1961, three major divisions can be made: 1) the encouragement of domestic assembly from 1961 to 1970; 2) the push toward local production from 1971 to 1978; and 3) adjustment of local production from 1978 on.

In 1962, the government delivered a proposal based on the Investment Promotion Act to encourage the assembly of automobiles. The main points of the presentation were as follows:

1) Tax exemptions for parts, equipment, and raw materials necessary for the construction of factories

2) Exemption for the first 5 years of operation from corporate tax, business tax, and taxes related to raw material imports

3) Relaxation of regulations on the ownership of land necessary for production

4) Permission for remittance abroad in foreign currency by foreign investors

5) Relaxation of immigration regulations for technicians and experts

6) Exemption from import duties and business taxes applying to the export of finished products and by-products.

Thus, the assembly of automobiles was entrusted to a great extent to foreign capital, but after entering the 1970s, regulations strengthened. In 1971 for the first time, a policy aiming at a switch to local production was announced. Since the current account balance showed a deficit, the purpose of the policy was to place a limit on imports. A ban on imports of finished passenger vehicles, motorcycles, and the like was also announced with this policy.

Jurisdiction over the automobile industry was then transferred to the Automobile Development Committee (ADC), made up of representatives from the Board of Industry (BOI). In 1971, the ADC announced a policy for the promotion of the automobile industry. Its basic contents were that:

1) Factories that are limited to assembly of vehicles should operate in only one of the following categories: passenger vehicles, buses, trucks, other commercial vehicles.

2) Existing automobile assembly plants can assemble only up to 3 series; only 1 series with an engine capacity exceeding 2000cc can be assembled; and newly established factories can assemble only 2 series of passenger vehicles or 3 series of commercial vehicles.

3) In terms of the local content ratio, manufacturers must use by 1973 domestic parts valued at greater than or equal to 25% of the tax-included value of the parts required for the assembly of a complete automobile. This deadline was later extended 1 year.

4) For establishing new automobile assembly factories, tangible fixed assets excluding property must equal at least 20 million baht in direct investment, and there must be a minimum production capacity of 30 vehicles per 8-hour work day.

The formula for calculating local content ratio is:

$$\text{Local Content Ratio} = \frac{\text{Value of Parts Obtained Domestically}}{(\text{Import Goods cif Value} + \text{Import Duties}) + \text{Value of Parts Obtained Domestically}} \times 100$$

Only truck production met the deadlines on time. The local content ratio for passenger cars halted at 20 to 22%. There are 3 reasons for the delay:

• There were many models being produced, and excluding common components, domestic production of parts was minimal or nonexistent

• Domestic component production did not meet the standards set by parent companies

• Imported parts were less expensive.

The goal in 1978 was to begin with a local content ratio of 30% by August 1979, and then increase the ratio by 5% per year until a level of 50% was reached 5 years later in August 1983. In March 1983, according to a Ministry of Industry notice, however, the ratio had been frozen at 45%. The goal for the basis of truck chassis with windshields was to begin with a local content ratio of 25% in December 1980 and increase 5% per year until a level of 45% was reached in August 1984.

At the end of 1984, the level reached 45% for passenger vehicles and 40% for the basis of chassis with windshield mentioned above. This fell one year short of the national goal set in 1978.

While it was clear that the ratios for both passenger and commercial vehicles stopped at 45%, debate broke out once more at the end of 1984, and in December of that year, a policy for the promotion of the automobile industry was announced. The basic contents included:

1) Encouragement of direct investment by large-scale automobile producers into part manufacturing

2) Planning for the rationalization of parts production through scales of production and the use of common components

3) Providing incentives such as lowering CKD related taxes for assemblers who have attained the 45% local content ratio

4) Issuing export credit to the domestic parts manufacturers who export.

5) Lowering the local content ratio for both passenger and commercial vehicles, using 50% as a base in 1985 and aiming for 70% by January 1, 1988.

The purpose of this policy was to promote the parts industry and to help it stand on its own feet.

After that, at the end of their conference in June 1986, the government, the assemblers, and the parts manufacturers concluded that the local content ratio for 1988 would be left undecided, but that policy for local content ratio would go unchanged through 1987. Also, a compulsory deduction scheme for components was introduced. The result was that the local content ratio for passenger vehicles was left at 47% in 1986 and 54% in 1987, while the ratio for 1988 remained to be the subject of a future study.

(5) Problems in Thailand's Automobile Industry

First, an outline of the method for local production, which can be called the Given Percent method, will be given. With a few exceptions, there is no designated list of items for local production. Rather, a fixed number of points is given to each part so that the total number of points equals 100. Local content ratio is calculated based upon the procurement of domestic parts. With this in mind, the local content ratio corresponds to the cost of the locally made products included in the vehicle price, and thus the point value of each part can be thought of as being derived from the weight of manufacturing costs.

Problems accompanying the change from imports to local production are as follows: 1) Manufacturing costs increase with the advance of local production, which involves switching from imported components to generally higher priced, lower quality domestic parts; 2) Prices of domestic parts are higher than those of CKD parts due to small lot, large variety production and the large number of vehicle models; 3) Taxes on CKD parts are set at the high levels of 112% import duty and 30% business tax in order to protect the domestic parts industry; 4) The components that are the object of the advance in local production are parts with important functions that require a high level of manufacturing technology. Generally, these parts are quality-controlled by the parent companies. Testing and grading of the parts must be concluded 2 years before merchandising them.

In order to reconstruct the problem-ridden automobile industry in Thailand, UNIDO suggested a plan. The main point was to stop capital-intensive small lot, large variety production, and instead to switch to capital-intensive, mass production of a small variety of parts, including those for export. Incentives for this purpose were: 1) Lowering the import duties related to imports of knockdown sets; 2) Giving a 20% export-value credit to parts exporters; and 3) Giving special privileges to manufacturers producing exports.

The exporting plan is rather temporary. The local content ratio is left at 45% and the compulsory component deduction list is frozen. In the fourth year after the plan was set in place, the local content ratio is to rise to 55%.

The characteristics peculiar to UNIDO's proposal are that it puts Thailand into the network of global parts production as a link in the strategy of international enterprises, attempts to accelerate industrialization, and strives to increase exports and production of industrial goods.

(6) Production and Retail Sales of Automobiles

Of the number of vehicles produced and sold, 1/3 are passenger vehicles, and the other 2/3 are for commercial use. Of the total number of vehicles manufactured, 90% are made by Japanese-affiliated companies. After 1980, the production level of automobiles changed from 70,000 to 100,000 vehicles. Although there were signs of a return to economic prosperity in 1986, neither sales nor production increased, due to marked increases in vehicle price resulting from the appreciation in the value of the yen and the rise in the local content ratio. The number of sales in 1987 halted at 100,000 vehicles, thus not even reaching levels in 1983 -1984.

In the future, if the economy continues to grow at the present tempo, both production and sales levels will probably increase, but too much growth cannot be expected. The reasons are: 1) The continued use of small lot, large variety production; 2) Increased costs due to the rise in local production; and 3) Limited entrance of new purchasing groups due to unavoidably high vehicle prices, which result from high import component tariffs and other taxes.

Accordingly, it is unlikely that demand will surpass 100,000 vehicles per year for a while. Production and sales levels for past years are shown in Table II-17.

Table II-17. No. of Automobiles Sold in Thailand by Manufacturer

(Unit: Cars)

Company Name	1986	1987	Share(%)
Passenger Cars			
Japanese Origin			
Toyota	6,254	8,046	29.87
Mitsubishi	2,587	4,390	16.30
Honda	870	3,405	12.64
Nissan	2,297	2,569	9.54
Others	2,749	1,223	4.54
Total	14,757	19,633	72.89
Non-Japanese Origin			
BMW	2,776	2,129	7.91
Peugeot	2,426	1,216	4.51
Volvo	807	1,302	4.83
Bentz	736	1,173	4.35
Others	979	1,485	5.51
Total	7,724	7,305	27.11
TOTAL	22,481	26,938	100.00
Commercial Vehicles			
Isuzu	16,112	23,554	31.89
Toyota	14,651	20,397	27.62
Nissan	11,544	14,566	19.72
Mitsubishi	4,021	5,177	7.00
Hino	1,721	2,841	3.85
Others	7,924	7,325	9.92
Total	55,973	73,860	100.00
GRAND TOTAL	78,454	100,798	–

Source: Far Eastern Economic Review

(7) Automobile Exports

In January 1988, 420 Mitsubishi vehicles were exported to Canada Chrysler as the first shipment in a plan to export 100,000 vehicles to Canada over the next 6 years. For Thailand, a country experiencing advancing industrialization, automobile exports are a new step forward. This was not, however, the first time that Thailand exported vehicles abroad. In December 1987, Siam Motors sent 40 Nissan automobiles to Brunei, but this action was a limited case of exports to a special market and was not as important as the export of the Mitsubishi vehicles.

Although the arrangement with Chrysler involved 100,000 vehicles, it looks as if exports will fall short of this level. How many vehicles can be exported will be decided through competition with other companies as well as through automobile quality. Furthermore, there is also Mitsubishi's strategy as a company to consider. While Mitsubishi exported 30,000 vehicles to Canada in 1987 alone, the level of future exports will also depend upon the number of exports transferred from Mitsubishi in Japan to Mitsubishi in Thailand.

Automobile assemblers in Thailand other than Mitsubishi will likely follow suit in the future, but it will be difficult for cars carrying expensive parts made in Thailand to compete in overseas markets. Notwithstanding, it will not be simple to ease the Thai government's fundamental policy of local production of automobiles or to continue to take special measures for automobile exports. Considering this point alone, it is very difficult to expect too much from automobile exports for the time being.

(8) Status of the Automobile Parts Industry

While the automobile parts industry has grown with the increase in the local content ratio of automobile parts, suffering from high costs as a result of small lot, large variety production also continues. The increase in local content ratio causes a deficiency of lots in the domestic sector alone, and thus, the necessity for a large enough to increase profits is growing.

1) According to the Ministry of Industry's register, the distribution of factories divided by the number of employees is as follows in Table II-18 below. Since the percentage of factories in the transportation machinery and tools industry employing less than 50 people is 94.4%, it can be inferred that parts industries operating on a small scale are common.

Table II-18.
Number of Factories by Scale of Employees (1984)

	No. of Factories	(%)
0 to 0 persons	1,644	(73.6)
10 to 49 persons	463	(20.7)
0 to 49 persons	2,107	(94.4)
50 to 99 persons	58	(2.6)
100 to 299 persons	46	(2.1)
More than 300 persons	22	(1.0)
TOTAL	2,233	(100.0)

Also, for every 5,000 workers in the assembly industry, there are 15,000 in the parts industry.

53.2% of the factories are located in Bangkok (Table II-19).

Table II-19.
Distribution of Automobile Parts Factories by Area

	Transportation Machinery and Tools Industry	
Bangkok	1,188	(53.2%)
Central	463	(20.7)
Five Provinces around Bangkok	240	(10.7)
East	90	(4.0)
North	144	(6.4)
Northeast	223	(10.5)
South	112	(5.5)
TOTAL	2,233	(100.0)

2) Structure of the Automobile Parts Industry

The parts manufacturing system in Thailand is unlike the Japanese vertical division of labor relationship involving a series of large, medium, and small enterprises. There are a few underlying reasons: 1) There are few assemblers and manufacturers of metal products and machinery; 2) Scales of production are small and imported parts are cheaper than domestically obtained parts; and 3) There are few small- and medium-sized enterprises whose quality, prices, and punctuality in delivery can be relied upon. Even so, the number of small and medium subcontracting enterprises is increasing as a result of the rise in import substitution that accompanied the policy of increasing local content ratio for automobiles.

Below, characteristics of the automobile industry are clarified through data on the division of labor structure in Thailand's automobile industry.

As shown in Table II-20, many parts manufacturers supply parts to a number of assemblers. This is a result of the low number of parts manufacturers and the lack of vertical linkages.

Of the main 130 manufacturers of parts shown in Table II-20, 45 companies (35%) were exclusive subcontracting enterprises supplying parts to only 1 assembler. Of those 45 companies, 32 supplied only 1 part, while 5 companies supplied 2 parts. 62 (48%) of the companies, or almost 1/2, supplied parts for over 3 assembly enterprises. It can also be said that many manufacturers produced a variety of parts and that the degree of specialization was low.

Because of the large quantity of parts, around 30,000 for 1 automobile, involved in the automobile industry, there are many difficult aspects involved in the build-up of regulations pertaining to the local procurement ratio and the production base.

3) Parts Manufacturing

The parts that have undergone a change to local production as a result of local content policy are varied. Up to now, high value-added, technology-intensive parts related to such things as engines, transmissions, gears, and electronics have depended upon imports. Normally, a change toward local production of parts takes place beginning with parts that have a low cost of production, and therefore, most manufacturers are switching to local production of the same parts. The rankings of the parts undergoing a change to local production as a result of the increase in local content ratio are as follows:

Parts whose local content ratio is 1) Between 10 and 20%: U bolts, radiator hoses, fan shrouds, tires, tubes, etc.; 2) Between 20 and 30%: brake drums, floor panels, rear ends, cross members, floor mats, mirrors, oil filter, fuel tubes, brake tubes, disk foils; 3) Between 30 and 40%: radiators, radiator grill emblems, exhaust pipes, fuel tanks, windshield glass, weather strips, starters, alternators, shock absorbers, etc.

(9) Plans for the Change to Local Production of Automobile Engines

The government of Thailand is planning the switch to local production of 1 ton pickup truck engines separately from the change to local production of other automobile parts. In response, 3 groups of Japanese-affiliated automakers have already petitioned

BOI for permission to establish new companies. They received approval in December 1986.

The 3 groups are: 1) Toyota and Siam Cement; 2) Nissan, Siam Motor, and Mitsubishi; and 3) Isuzu, Mazda, and Ford. The production plans at the time of approval in December 1986 were: For group 1), 24,000 diesel and gasoline engines per year; for group 2), 13,300 diesel engines and 17,000 gasoline engines per year; and for group 3), 24,000 diesel and gasoline engines per year.

The 3 groups are already constructing their factories, and they are expecting to begin local production in 1989.

Table II-20. Subcontracting Structure in Thai Automobile Industry

Assemblers	Assemblers	%	1	2	3	4	5	6~10	11~12	21~
1	45	34.6	32	5	5	2	1	0	0	0
2	23	17.7	8	8	4	1	1	1	0	0
3	20	15.4	6	2	4	3	0	3	1	1
4	2	1.5	0	1	0	0	1	0	0	0
5	9	6.9	2	1	3	0	1	1	1	0
6~10	19	14.6	7	2	3	0	0	4	3	0
11~18	12	9.2	1	2	1	1	1	1	4	2
TOTAL	130	100.0	56	21	20	7	5	10	9	2
	%	100.0	43.1	16.2	15.4	5.4	3.8	7.7	6.9	1.5

Note: 1984 passenger cars used as basis.
Source: Ministry of Industry

2-1-2. Plastic Goods Industry

(1) The Start of the Plastics Industry

The plastics industry began as part of Thailand's shift to import substitution. It continued in this capacity through the 1950s, but in the 1960s, the industry expanded. Until 1968, it functioned as a forming and processing industry and imported all of its raw materials. In 1969, there was a total of 1,000 companies in this field.

In the latter half of the 1970s, Thailand's plastics industry formed joint ventures with companies in Taiwan and Hong Kong and subsequently began exports of plastic toys, artificial flowers, and so on. Recently, the industry's importance as a supplier of parts for automobiles and home appliances has also grown.

(2) Production of Raw Materials

In 1984, there were 6 manufacturers in Thailand of raw materials for plastic goods. Their annual output, as shown in Table II-21, was 170,960 tons.

(3) Production of Plastic Goods

There is a total of 2,000 plastic goods processors operating in a variety of different fields. They produce a large output of goods through the use of blow molds, injection molds, compressive molds, and so on.

The most common processing method is the injection mold, which occupies 70% of total output quantities. The main products manufactured through this method are buckets, toys, household goods, and so on. High-technology, high value-added products using fluorine resin, polycarbonates, or polyacetyls are not handled.

As for the other techniques, plastic bottles and containers are made with blow molds, and melamine resin containers are produced through the extrusion method. Ice cream cups, straws, tape, and the like are manufactured with compressive molds, and goods such as ashtrays are made with laminating molds (Table II-22).

The annual rate of growth for the plastics forming and processing industry between 1972 and 1979 was 12.2% per year, and total production for 1984 can be estimated at 300,000 tons.

Because of a lack of statistical data, it is difficult to anticipate future production in the plastics industry. However, even though proper calculations cannot be made, the future growth rate might look something like that in Table II-23 if the assumption is made

Table II-21. Producers of Plastic and Intermediate Products

Producers	Products	Production Capacity (Tons/Year)
Thai Plastic and Chemical Co., Ltd.	Polyvinyl Chloride (PVC) *resin & compounds*	60,000
Thai Petrochemical Industry Co., Ltd.	Low density polyethylene (LDPE)	65,000
Pacific Plastic Industry Co., Ltd.	Polystyrene (PS)	22,000
Siam Chemical Industry Co., Ltd.	Alkyd melamine resin	12,000
	Acrylic resin	1,800
	Polyurethane resin	960
Internal Resin Co., Ltd.	Alkyd/Phenolic resin	7,200
Thai Polystyrene Co., Ltd.	Expandable (PS)	2,000
TOTAL		*170,960*

Source: Petroleum Authority of Thailand

Table II-22. Production of Selected Plastic Production, 1972-1980

Year	PVC Pipes *(tons)*	Vinyl Floor Tiles *(sq.m.)*	PVC Fabrics *(tons)*	Plastic Bags *(tons)*	Acrylic Sheets *(tons)*	Plastic Flower *(tons)*	Melamine Tableware *(tons)*
1972	1,183.15	509,964	N.A.	N.A.	–	–	–
1973	2,478.60	716,068	N.A.	N.A.	–	–	–
1974	1,449.00	396,638	8,235	2,786	1,678	N.A.	–
1975	1,792.95	485,334	8,877	3,464	1,749	N.A.	188.54
1976	2, 624.04	708,329	11,750	4,600	1,713	1,704	465.67
1977	3,301.63	837,025	9,500	5,934	2,379	2,746	636.36
1978	3,900.00	1,164,615	10,500	6,748	2,774	2,941	866.98
1979	4,485.00	1,391,341	N.A.	N.A.	2,650	N.A.	N.A.
1980	4,760.00	1,910,321	N.A.	N.A.	2,344	N.A.	1,790.00

Source: Ministry of Industry
IFCT
Board of Investment
Thai Farmers Bank
Ministry of Commerce

that the trends in the production of plastic goods are similar to those for other chemical products. Using a linear regression method and letting x = the year and y = production from the table, the equation becomes y = -31,292 + 451.6 x (r = 0,9949). From this, the anticipated output levels for 1986 becomes 7,545 million baht. For 1993, the output becomes 10,707 million baht, and for 1998, 12,965 million baht. These are increases of 42.3% and 72.3%, respectively, over 1986's 7,545 million baht. According to this method, the average annual growth of the plastics industry until 1993 is 5.16%, and from 1994 to 1998, it is 3.9%.

In any case, whether surveying the number of plastics goods manufacturers or the past production status of major plastic goods, there has been a remarkable trend toward growth, and future development looks promising.

(4) Factory Locations and Division of Factories by Employee Base

Most factories are located in Bangkok, where there is a large market for their products and raw materials can be conveniently obtained. There are less than 10 factories located in the eastern, northern, or southern sections of Thailand (Table II-24).

Table II-25 shows the number of factories by the employee base. An overwhelming 64% of the factories have from 0 to 9 employees, and 95.7% have from 0 to 49. From this data, it can be inferred that most plastics manufacturers operate on a small scale.

(5) Exports

Exports grew from 688.8 million baht in 1981 to over the 1.2 billion mark in 1984 when they were 1,297.2 million baht. Products included tableware, kitchenware, raincoats, plastic bags, and so on (Table II-26).

The main countries/areas to which exports were sent were Great Britain, Singapore, Hong Kong, the United States, and South Africa.

(6) Imports

Imports of polymer and plastic raw materials are as shown in Table II-27.

Each year, imports of plastic goods show a high growth rate due to flourishing domestic demand. From 1981 to 1985, imports of plastic goods grew by 13% (Table II-28).

Table II-23. Trends in Production of Chemical Products (1972 Prices)

(Unit: Million Bahts)

Year	1979	1980	1981	1982	1983	1984	1985	1986
Price	4,177	5,035	5,342	5,732	6,199	6,601	7,084	(7,545)
Growth Over Previous Year (%)	–	20.5	6.1	7.3	8.1	6.5	7.3	6.5

Source: NESBD national income statistics
Note: Figures in parentheses indicate estimates.

Taable II-24. No. of Factories by Region (1984)

	Plastic Products	
Bangkok	1,283	(88.2)
Center	134	(9.2)
In Center, five provinces around Bangkok	131	(9.0)
East	8	(0.6)
North	6	(0.4)
Northeast	14	(1.0)
South	9	(0.6)
TOTAL	1,454	(100)

Source: Ministry of Industry

Table II-25. No. of Factories by Scale of Employees (1984)

	Plastic Products	
0 to 9 persons	930	(64.0)
10 to 49 persons	462	(31.8)
0~49 persons	1,392	(95.7)
50~99 persons	35	(24.0)
100~299 persons	24	(1.7)
More than 300 persons	3	(6.8)
TOTAL	1,454	(100.0)

Source: Ministry of Industry

Table II-26. Export Value of Plastic Products

	1981	1982	1983	1984	1985	Jan-Nov 1986
Tableware & Kitchenware	79.1	99.6 (25.9)	120.1 (20.6)	169.4 (41.0)	224.0 (32.2)	291.3 (43.8)
Raincoats	48.3	33.6 (-30.4)	47.7 (42.0)	49.8 (4.4)	189.0 (279.6)	68.8 (-61.0)
Plastic Bags	96.8	104.3 (7.7)	189.7 (81.9)	351.6 (85.3)	472.5 (34.4)	646.9 (54.9)
Tape Glue	65.6	62.8 (-4.3)	80.6 (28.3)	68.1 (-15.5)	89.2 (31.0)	89.7 (8.2)
Ornaments	1.8	2.4 (33.3)	2.5 (4.2)	5.2 (108.0)	8.8 (69.2)	10.3 (30.4)
Others	397.2	410.0 (3.2)	497.6 (21.4)	653.1 (31.3)	278.5 (-57.4)	165.2 (-39.0)
TOTAL	688.8	712.7 (+3.5)	938.2 (+31.6)	1,297.2 (+38.3)	1,262.0 (-2.7)	1,272.0 (+9.8)

Source: Customs Department
Note: Figures in parentheses indicate percent growth over previous year.

Table II-27. Polymer Imports, 1977-1980

(Tons, Million bahts)

	1977		1978		1979		1980	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
PE	65,435	740.8	73,245	812.4	85,427	1,515.8	45,657	939.7
PP	19,784	261.0	32,066	369.9	54,990	795.5	32,008	646.6
PS	6,672	93.0	5,749	78.5	2,275	42.7	1,683	40.0
PVC	8,332	120.4	5,560	95.9	9,793	191.3	4,785	117.1
Other	41,186	644.4	42,308	685.7	51,059	1,029.9	28,677	810.4
TOTAL	141,409	1,859.6	158,928	2,042.4	202,544	3,575.2	112,805	2,553.8

Source: Cusroms Department

Table II-28. Import Value of Plastic Products

(Unit: Million Bahts)

	1981	1982	1983	1984	1985	Jan-Nov 1986
Plastic Tubes and Pipe	39.6	44.4 (12.1)(	109.6 (146.8)	106.5 (-2.9)	103.4 (-2.9)	143.4 (45.7)
Tableware & Kitchenware	13.1	8.6 (-34.4)	8.9 (3.5)	6.3 (-29.2)	10.3 (63.5)	44.3 (381.5)
Plastic Bags & Woven Sacks	34.6	25.2 (-27.2)	30.6 (21.4)	44.2 (44.4)	54.5 (23.3)	53.1 (6.2)
Plastic Corks	16.6	20.1 (21.1)	24.9 (23.9)	27.0 (8.4)	28.1 (4.1)	37.8 (48.2)
Tape Glue	19.6	24.4 (24.5)	22.6 (-7.4)	21.3 (-5.8)	23.1 (8.5)	13.6 (-34.9)
Plastic Tiles	40.0	12.3 (-69.3)	11.2 (-8.9)	5.6 (-50.0)	11.5 (105.4)	4.8 (-48.4)
Others	475.7	460.1 (-3.3)	582.1 (26.5)	700.2 (20.3)	788.3 (12.6)	924.4 (31.2)
TOTAL	639.2	595.1 (-6.9)	789.9 (32.7)	911.1 (15.3)	1,019.2 (11.9)	1,221.4 (33.0)

Source: Customs Department

(7) The Government's Promotion Policy for the Plastics Industry

1) Government Promotion

In December 1980, there were 44 companies in the plastics goods manufacturing industry under the guidance of BOI Incentives for these companies included exemption from corporate tax and exemption from import duties on raw materials and machinery, but in exchange, there were some conditions. The conditions set down for 1980 are listed in Table II-29.

2) Tax System

The tax system for plastic goods is designed to protect the domestic industry. Import duties on monomers used in Thailand to produce polymers are no more than 10%, while, in contrast, a 40% tariff is assessed on imports of polymers for use as industrial raw materials. Duties on raw materials used for manufacturing printing ink, plywood, and hardening agents for rubber are 10%, as are tariffs on polyethylene and polypropylene used for coverings on electrical wires. Import duties on the finished products, however, are as high as 30 to 100% (Table II-30).

Additionally, BOI imposes a surcharge of 10% in order to protect domestic manufacturers.

After 1973, rebates of import tariffs were begun for exports of specified goods. In 1982, this applied to 11 products (Table II-31).

(8) Problems in the Plastics Goods Industry

The cost of plastics production in Thailand is high, because of two reasons: 1) Approximately 90% of the major raw materials must be imported; and 2) The importer must pay an import duty of 40% for pellets such as LDPE and PP.

Table II-29. Plastic Production Acitivities Eligible for Promotion, as of December 1980

Type	Size & Conditions
Petrochemicals (Except HDPE & LDPE)	New project: capital investment of not less than 50 million bahts excluding cost of land and working capital. Expansion project: capital investment of not less than 15 million bahts excluding cost of land and working capital.
Plastic or Plastic Coated Products (Except Plastic Woven Sheets)	Capital investment of not less than 5 million bahts exluding cost of land and working capital.
Artificial Leather*	Condition:must be mostly or totally exported.
Artificial Flower and Tree*	Capital investment of not less than 2 million bahts excluding cost of land and working capital. Condition: must be totally exported.
Manufacture of Cellophane	Capital investment of not less than 20 million bahts excluding cost of land and working capital.
Manufacture of Packaging Products: (Except Polypropylene Film)[1]	
Metallized Paper on Plastic Film or Other Film*	Capital investment of not less than 40 million bahts excluding cost of land and working capiltal. Condition: 1) Not less than 60% of registered capital must be owned by Thais. 2) Annual export at least 40% of annual sales.
Polystyrene Film*	Capital investment of not less than 20 million bahts excluding cost of land and woking capital. Condition: 1) must use local raw material. 2) Annual export at least 30% of annual sales.

Notes: [1] Prior to the suspension of promotion priviledges, one of the conditions stipulated was that at least 30% of annual sales must be exported.
* Export promotion

Source: Board of Investment

Table II-30. Import Tax Rates on Plastic Products

Product	Tax Rates	
	Import Duties % CIF	Business and Municipal Taxes
Artificial Resins & Plastic Materials	40%	7.7%
a) Used as Raw Materials [1]	60%	7.7%
b) Others [2]	100%	7.7%
Articles of Artificial Plastic Materials, Travel Goods, Footwear	100%	7.7%
Articles of Plastic Materials	60%	1.5-15.0%
Baby Carriages	30%	7.7%
Toys, Games & Sporting Goods	30-80%	7.7%
Artificial Flowers	30%	7.7%

Source: Customs Department
Note: [1] Import duties are reduced to 10% on raw materials for rubber hardening, plywood, paint button, printing ink, polyethylene, polypropylene for telephones, and electric wire and cable.
[2] Import duty is 30% on cellophane for adhesive tape.

Table II-31. Tax Refund Rates for Plastic Products

Year Tax Refund Rate Announced		Tax Refund Rate (Baht)		
		A[1]	B[2]	Unit
1973	Vinyl Floor, Tile	1.05	0.7	kg
1974	Plastic Button	634-696.50	59.67-60.45	100 kg
1974	PVC Pipe and Fitting	414.90	123.60	ton
1975	Dop	1,618-1,644	25.16--50.68	ton
1975	Cellophane Tape	14,670	564.40	ton
1975[3]	PVC Sheet	1,152-2,741	6.02-181.90	ton
1976	Acrylic Sheet	3,841	55.08	ton
1977	Polyethylene Bag	645.58	10.94	100 kg
1979	PVC Sheet	1,774.83-4,679.08	5.52-110.22	ton
1979	PVC Resin, Compound			
	— Resin	1,175.95	18.87	ton
	— Compound	1,4511.90-3,323.03	6.44-7.18	ton
1979	PVAc dispersion	778.28-1,388.68	35.74-35.94	ton
1979	Plastic Flower	5.46	1.67	kg

Source: Ministry of Finance
Note: [1] Full tax refund rate
[2] Tax refund rate if import duty already exempted
[3] Replaced by 1979 rate

2-1-3. Other Industries

(1) Motorcycle Manufacturing Industry

1) Production of motorcycles in Thailand began in 1966 following the implementation of the 1964 Investment Promotion Act. At first, there was almost no difference between the taxes on CKD component sets and those on imports, so the small-scale domestic producers continued under severe operating conditions. In 1969, production reached 33,000 vehicles, thus occupying half of the market. In 1975, output totalled 84,000 units, or 65% of the market.

A ban was placed on imports of complete vehicles in January 1978, and as a result, retail sales increased until 1983.

2) After 1983, retail sales fell to 31,700 vehicles in 1984, 26,200 in 1985, and 25,000 in 1986. These are a few reasons:

- The devaluation of the baht in November 1984
- Lowering of taxes on CKD in April 1986
- An increase in retail prices after the end of 1986 as a result of rises in components costs induced by the appreciation in the value of the yen; and
- Decreased earnings in the agricultural sector, where a large portion of the motorcycle market is located, as a result of a drop in agricultural product prices (Table II-32).

3) There are approximately 2 million motorcycles in operation, and 80% are registered outside of Bangkok. In Bangkok, motorcycles are used to commute to work and school, to transport packages, and in addition, outside of Bangkok, as a taxi service. In terms of price, a vehicle with a 100cc engine capacity costs 25,000 baht. Considering that the salary level in the city is around 2,000 baht per month, the price is as high as annual income.

4) The market is almost 100% dominated by Suzuki Motor Co., Ltd., Honda Motor Co., Ltd., Yamaha Motor Co., Ltd., and Kawasaki Heavy Industries, Ltd. There is also 1 local assembly company that receives its parts supply from Peugeot.

5) Just as for automobiles, the government of Thailand is striving to localize production of motorcycles. The plan for localization started in 1971 and required that 50% of the parts be obtained domestically after 2 years. In September 1978, this level was raised to 70%. Presently, most parts, excluding those in the engine, are produced domestically, and there is a trend toward increasing costs. The rise in costs is an outgrowth of the push toward domestic production of functional components.

Table II-32. Production and Sales of Motorcycles

(Unit: 1,000)

Item	1977	1980	1983	1984	1985	1986
No. produced	150	284	313	321	230	241
No. sold	208	291	320	317	262	250

Source: Ministry of Industry

6) Plans for the localization of engine production have also begun. In November 1986, BOI gave permission to 4 Japanese-affiliated manufacturers to directly invest in 1 local production company. Along with this, the government instituted a licensing system for imports of 41 units of 250cc engines from June 5, 1987. The condition imposed by BOI for receiving approval was that the localization would start at 30% at the end of 1988 and move to 40% in 1988, 50% in 1989, and 80% in 1990.

Each company produces 5 or 6 different types of engines, thus bringing the total to 25 or 30 different varieties. The companies must plan technology transfers for production, and in terms of the scale of production, increased costs are unavoidable. Each company is also considering circulation of components as well as molds and dies among its industrial bases in Asia, and is planning to export engines and complete vehicles from Thailand.

7) Finally, there is conjecture among local Japanese-affiliated enterprises that, considering Taiwan's diffusion ratio of 1 vehicle for every 6 people, a firm domestic market of 10 million vehicles is likely to exist in Thailand's future.

(2) Electric and Electronics Industry

1) There are 50 large-scale manufacturers of electric and electronic goods. If small and medium enterprises are included, there is a total of 300 manufacturers.

2) Products made in Thailand include color televisions, black-and-white televisions, radios, radio-cassette players, electric fans, ventilation fans, air conditioners, electric pots, irons, hair dryers, light bulbs, fluorescent bulbs, storage batteries, dry cells, all-purpose motors, transformers, electrical power supply machinery, telephones, and so on. Products imported into Thailand include video machines, high quality audio equipment, washing machines, microwave ovens, and small electrical appliances like toasters, mixers, and other kitchen appliances.

3) Although Thailand still relies heavily on imported components, the change to local production of refrigerator compressors and television picture tubes is progressing. This is a result of the government's promotion policy, which is an outgrowth of the Investment Promotion Act.

4) Demand levels increased 10% per year, and a boom occurred after the reduction of business taxes in 1982. With the devaluation of the baht in 1984, however, demand declined. In 1986, demand gradually came back with the return of prosperity. In the future, there will be an rise in demand for electrical products as a result of increased income and the popularization of electronic goods.

5) Particularly in the past few years, exports by large-scale IC assembly enterprises from the United States and exports by miniature bearing manufacturers from Japan have increased. Fifth overall in export status in 1985 were IC exports, occupying 4.6% of total exports and totalling 8.8 billion baht. After the decrease in international competition following the appreciation in the value of the yen, direct investment from Japanese electronics manufacturers using Thailand as a production and exporting base became more conspicuous.

2-2. Status and Trends of Mold and Die Demand in Industries that Utilize Molds and Dies

2-2-1. Automobile and Motorcycle Industries

1) It is difficult to grasp the extent of demand for molds and dies in Thailand, a country in which not only industry-specific statistics, but also statistics for overall industry, are nonexistent.

According to a 1987 questionnaire survey issued by MIDI, 35 out of 60 companies, or 58.3%, were manufacturing molds and dies for use in the production of automobile parts, as indicated in Table II-4. This percentage showed a 6% increase over the results of a similar survey in 1983, in which 33 out of 60 companies, or 55%, were manufacturing molds and dies for this purpose. The extent of mold and die demand in the automobile industry can be inferred from the information given above.

2) Presently, there are over 200 parts manufacturers, and of those companies, 66 are promoted companies of BOI. In parts production, 90% is passed down to supply domestic demand, and 10% is exported. The value of exports in 1982 was 176 million baht. In 1985, it was 311 million baht.

3) The reason for the increase in mold and die demand lies in the growth of the local content ratio in the automobile industry. The ratio was 54% in July 1987 and 65% in July 1988 for passenger vehicles. For commercial vehicles, it was 54% in both July 1987 and July 1988. The imports of molds and dies for metals, which are indispensable to the automobile industry, also rose sharply from 21.32 million baht in 1984 to 67.98 million baht in 1985 and 90.72 million baht in 1986.

4) In contrast to the increased imports, the majority of Japanese-affiliated automakers and parts manufacturers, along with producing producing basic parts such as panels inside Thailand, made every effort to give technological instruction to the subcontracting enterprises in their industrial networks. The purpose was to enable the subcontractors to produce quality parts to meet the demand, including molds and dies.

5) Additionally, the advance of capital from mold and die manufacturers in the Japanese automakers' industrial networks is also gradually increasing. This results from the need to control rising costs that stem from the sudden increase in costs of imported parts. The rising costs, in turn, are due to the appreciation in the value of the yen and the increased local content ratio. Moreover, the profit motives of the Japanese automakers, who intend to export parts or completely manufactured automobiles, coincide with those of the mold and die manufacturers, who face high manufacturing costs inside Japan.

For example, Toyota Auto Body Co., Ltd. reinforced the equipment in its mold and die division in October 1987, and it plans to export molds and dies to Japan. Furthermore, Toyota Motor Corporation is exporting molds and dies made by Thai-Hino Motors and CH Autoparts to Taiwan. Nippondenso Co., Ltd. also established a manufacturing company as a joint concern. It is planning to export molds and dies for cold forging, die cast, and iron plate press use.

Thus, the the Japanese-affiliated mold and die manufacturers base their presence upon the fact that the cost of production is one-half to one-fifth less expensive than in Japan, and the fact that mold and die technology is growing in Thailand.

2-2-2. Plastics-Related Industries

1) As shown in following Table II-3, the number of mold and die manufacturers that produced molds and dies for plastics increased in a MIDI survey. Out of 60 companies that were the focus of the survey, the number grew from 27 (60 minus 33) in 1983 to 36 (60 minus 24) in 1987. It can also be concluded from this information that there was an increase in demand for molds and dies in plastics industries. The growth in demand for injection molds, which were produced by 33 companies (55%) especially stands out.

2) There are presently 2,000 companies involved in the plastics forming and processing industry. This number is a reflection of both the increase of plastic toy and artificial flower manufacturing and the development of demand for parts supply by the automobile and household electrical appliance industries.

3) There are a variety of formed goods, including vinyl and sheet film, tableware, various kitchenware, toys, furniture, automobile parts, components for household electrical appliances, and computer components. However, high-technology, high value-added products made from engineering plastics are not being manufactured.

4) The problem that the plastic goods face can be viewed in a general manner. While the domestic supply of molds and dies is gradually increasing, the value of mold and die imports is also growing. Looking at this trend, plastic molds imports, including rubber molds and dies totalled 289.6 million baht in 1985 and 429.3 million baht in 1986. This is due not so much to a lack of quantity in domestic supply, but more to an inability to supply molds and dies involving high accuracy and complex form. Thus, the problems that remain for Thailand's molding and processing industry as a result of its dependence on foreigners is not only pressure on costs, but also the difficulty in nurturing the development of new products.

2-2-3. Trends in Mold and Die Imports

1) Most molds and dies presently being imported into Thailand consist of large, complex, and highly accurate ones. The value of imports, as shown in Table II-33, rose 38.2% from 148.5 million baht in 1979 to 205.2 million baht in 1980. Thereafter, import value fell to 178 million baht in 1982, but completely turned around in 1983 and rose 68.8%. Then, in 1985, there was a slight drop, but progress increased satisfactorily and import value reached 595.3 million baht in 1986.

In Table II-33, 1 stands for press dies (CCCN 820521); 2 stands for wire drawing and extrusion dies (CCCN 820528); 3 stands for die cast molds, casting molds, and molds for powdered alloys (CCCN 846002); and 4 stands for plastic molds, rubber molds, and molds for ceramics (CCCN 846003).

Divided by percentages of each type, in 1986, total value for category 1 (CCCN 820521) was 68 million baht, or 11.4% of the total import value of 595.30 million baht; the value for category 2 (CCCN 820528) was 5.6 million baht, or 1.0%; for category 3 (CCCN 846002), 90.7 million baht, or 15.2%; and for category 4 (CCCN 846003), 431 million baht, or 72.4%.

The largest growth rate between 1979 and 1986 was for category 1 (CCCN 820521) with an average annual growth rate of 35.4%. Next was category 3 (CCCN 846002) with a rate of 32.2%, followed by Category 4 (CCCN 846003) with a rate of 19.6%, and finally, category 2 (CCCN 820528), for which the import value effectively did not increase. Though they increased in terms of monetary value, categories 2 (CCCN 820528) and 3 (CCCN 846002) decreased in terms of product quantity. Category 1 increased remarkably in terms of quantity. Press dies are used frequently for automobiles and motorcycles. Since these industries advanced in response to the increase in local content ratio, imports of molds and dies increased in category 1. While most of category 4 (CCCN 846003) is composed of plastics molds, it cannot be said that the growth of plastic goods production is increasing. The increase in domestic production of molds and dies for plastics can be considered as the reason. (A 1987 MIDI survey also showed that the number of manufacturers of molds and dies for plastics is increasing.)

2) Table II-34 shows comparative ratios of imports and exports for Thailand and Korea. For example, in 1979, Korea's ratio was 3.4 against Thailand's 12.7. Generally, a lack of excess production capacity means a lack of exporting strength, and the portion of domestic supply that is lacking is filled in by imports. These figures show that Thailand has a lower production capacity than Korea, and that Thailand depends heavily on

imports. Incidentally, Korea's ratio of imports to exports rose to 5.3 in 1980, but fell thereafter to under 3.

Thailand's import to export ratio once declined to 6.1, but returned again to 14 in 1983-1984. The decline in 1982 can be seen as a drop in imports (there was a 9.8% decrease in imports from the previous year and a 68.8% increase in imports the following year) due to a decline in prosperity.

3) All the molds and dies that Thailand imports are high grade ones. This means that there is an increasing need for Thailand to develop its exporting industry and to improve the quality and grade of its export products. The mold and die import outlook was formulated under the following conditions. While consistent data is nowhere to be found, there is a possibility that within the year import and industrial statistics will be obtainable. Additionally, planned growth rates have been established in the 6th 5-year plan for industrial production.

Furthermore, in a country like Thailand, in which production capacity of molds and dies is low, imports of molds and dies and correlation in industrial production will certainly be high.

The linear equation $y = A + Bx$, letting x = industrial production and y = imports of molds and dies, was used to determine the coefficients A and B. Using the numbers from Table II-33, $A = -312.5$, $B = 0.00359$, and the coefficient of correlation $r = 0.90$. Provided that:

$$B = \frac{n \cdot \Sigma xy - \Sigma x \cdot \Sigma y}{n \cdot \Sigma x2 - (\Sigma x) 2} \quad \text{and} \quad A = \frac{\Sigma y - B \cdot \Sigma x}{n}$$

In the 5 years after 1987, the 3-year and 5-year import values will be 672,000 baht in 1989 and 737,000 baht in 1991, if the industry grows at the planned annual growth rate for industrial production of 6.6% given at the 6th 5-year plan. This follows from the equation $y = -312.8 + 0.00359x$.

Moreover, looking at the recent growth in exports of industrial products from Thailand and judging from the results of a survey in which enterprises were interviewed (separate section), this level of imports can be considered close to reality.

Table II-33. Mold and Die Imports and Industrial Production in Thailand

Type	Unit	1979	1980	1981	1982	1983	1984	1985	1986
1. Punches and dies for pressing stamping sheet metal, perforating cutting dies, punches for machine tools [Code820521]	kg	17,418	10,392	45,665	42,337	199,137	255,697	48,916	364,591
	1,000 bahts	8,159	7,214	24,321	12,929	47,632	52,951	19,613	68,014
2. Dies for wire drawing, extrusion dies for metal [Code820528]	Units	9,709	9,739	4,134	6,879	9,742	32,309	12,005	3,476
	1,000 bahts	4,531	3,714	3,257	3,514	6,393	21,661	8,078	5,608
3. Molds for metal & metallic carbides [Code846002]	Pieces	7,418	1,108	1,687	1,016	884	389	1,057	821
	1,000 bahts	12,858	21,169	12,451	9,622	26,948	21,316	67,892	90,724
4. Molds for non-metal [Code846003]	kg	905,203	1,439,245	911,628	1,167,547	1,553,357	2,614,364	1,473,844	1,469,516
	1,000 bahts	122,933	173,151	157,308	151,955	219,463	330,211	289,560	430,959
Total Imports of Molds and Dies	1,000 bahts	148,481	205,248	197,337	178,020	300,436	426,139	385,143	595,305
Industrial Production	Million bahts	109,740	134,515	158,272	164,649	176,200	196,275	209,014	226,541

Source: Trade statistics
NESDB national income statistics

Table II-34. Import/Export Ratio of Thailand and South Korea

	Item	Unit	1979	1980	1981	1982	1983	1984
Thailand	Imports (M)	Million bahts	148.5	205.2	197.3	178.0	300.4	426.1
	Exports (X)	Million bahts	11.5	8.9	15.2	29.0	21.3	29.9
	M/X	%	12.7	23.1	13.0	6.1	14.1	14.3
South Korea	Imports (M)	Millon won	14,621	24,140	13,373	15,923	25,269	35,207
	Exports (X)	Million won	4,292	4,592	4,314	7,285	11,300	12,240
	M/X	%	3.4	5.3	3.1	2.2	2.2	2.9

Source: Customs statistics.
Materials of Korean Economic Planning Board, Industrial Statistics and Tariffs Agency

2-3. Export Market Perspective

2-3-1. Mold and Die Production in Major Countries and the Status of Trade

Standardized statistics for the values and amounts of the world's mold and die production do not exist. Depending upon the country, various statistics focusing on molds and dies may or may not exist, and even if they do, the extent of their item lists differ from country to country.

Given this set of circumstances, a look at the production and trade status of molds and dies in the major nations is appropriate for the purpose of exploring the possibilities of export by Thailand.

(1) Production of Molds and Dies in Major Nations

According to a presentation by the secretariat in the International Special Tooling Association (ISTA), the total value of production from the 15 member nations, listed immediately below, totalled ¥1,982.919 billion (figures converted to yen by the Japan Die and Mold Manufacturing Association; see Table II-35).

ISTA members as of 1986 were: The United States, Japan, West Germany, Italy, France, Great Britain, Spain, Switzerland, Holland, Canada, Belgium, Finland, Portugal, Sweden, and Denmark.

Ranked by country, the United States was first, with a production value of ¥940,815 million and occupying 47% of total production value. This was a decrease of 4.4% from the results of a 1983 survey. Japan was second, with an output of ¥375,498 million, which was 18.9% of total production value and a 16% increase over 1983. Next was West Germany with ¥208,517 million, which was 10.5% of the total and a 13.6% increase over 1983. Italy followed with a production value of ¥91.8 billion, which was 4.6% of the total and a 0.7% decrease from 1983. Finally, France had a production value of ¥67,575 million, 3.4% of the total and a 37.5% increase from 1983.

However, Japan uses machine statistics collected from 641 companies each with over 20 employees to calculate its manufacturing value. If a switch were made to industrial statistics based upon the total production value in all of Japan, value of output in 1986 becomes ¥1,225.042 billion, thus exceeding the United States' output. Furthermore, Japan's share of the value of the ISTA's entire production of ¥2,832.4 billion becomes 43.2%. The combined total share of production by Japan and the United States comprises an overwhelming 76.5% of ISTA's total.

Table II-35. Annual Production (1986)

(Unit: Million Yen)

	U.S.	Japan	West Germany	France	U.K.	Spain	Switzerland	Netherland	Canada	Belgium	Finland
Punch and Press Dies	334,847	150,228	101,325	17,304 [1]	12,064	26,229 [1]	13,536	30,656	9,417	4,154	3,592
Plastic and Rubber Molds	295,998	161,148 [4]	49,643 [4]	43,527 [5]	17,145	22,439 [1,4]	19,600	7,648	21,353	17,512 [4]	3,750 [3]
Diecast Dies	68,912	21,287	8,777	6,744	2,343	3,794 [1]	3,472			1,666	1,134
Jigs and Fittings	129,384		33,184		24,801		8,816		2,506	104	1,670
Standard Tools and Parts	111,674	42,775 [2]	15,588		6,328	2,006 [1]	1,776		3,532	13,316	189
TOTAL	940,815	375,498 [3]	208,517 [6]	67,575	62,681 [6]	54,468 [1]	47,200	38,304	36,808	36,752	10,335

	Portugal	Sweden	Denmark	Sub Total	Italy	TOTAL
Punch and Press Dies		3,283		706,675		
Plastic and Rubber Molds	6,080 [1]	2,612 [4]		668,455		
Diecast Dies	320 [1]	491		118,940	91,200	
Jigs and Fittings				200,465		
Standard Tools and Parts with less than 25 workers.				197,184		
TOTAL	6,400 [1]	6,366 [3]	- [8]	1,891,719	91,200 [1]	1,982,919

Note:
1. Estimate
2. Including other molds, dies, and special tools not mentioned in these statistics.
3. Including in-house production by shops in automobile and plastic industries.
4. Including tire molds. 5. Including glass molds.
6. Not including figures for business establishments which are less than 25 workers.
7. 1985 figures. 8. Not yet submitted.

GRAND TOTAL 1,982,919

Excluding Denmark, which reported no statistics to ISTA, and Italy, which only reported total value, the values of different mold and die types for the other 13 nations are as follows: Molds and dies for punch press use had the greatest value at ¥706,675 million and occupied 37.4% of total production value. Next was the value of molds and dies for plastics and rubber use, totalling ¥668,455 million or 35.3% of the total value; then jig fixtures at ¥200,465 million or 10.6%; standard tool parts at ¥197,184 million or 10.4%; and molds and dies for die cast use at ¥118,940 million or 6.3%. Divided by product and by country, again excluding Denmark and Italy, the United States was first in production value of molds and dies for punch press use at ¥334,847 million, 47.4% of ISTA's total value of ¥706,675 million; Japan was second at ¥150,288 million or 21.3%; third was West Germany at ¥101,325 million or 14.3%. For molds and dies for plastics and rubber, the United States was first at ¥295,998 million or 44.3% of the ISTA's total ¥668,455 million; Japan was second at ¥161,148 million or 24.1%; and third was West Germany at ¥496,643 million, or 7.4%. For molds and dies for die cast use, the United States was first at ¥68,912 million or 58.0% of the ISTA's ¥118,940 million total; Japan was second at ¥21,287 million or 17.9%; West Germany was third at ¥8,777 million or 7.4%. Since some of the countries did not report statistics for jig fixtures, those figures will not be mentioned. In standard tool parts, the United States ranked first at ¥111,674 million or 56.6% of the total ISTA production value; Japan was second at ¥42,775 million or 21.7%; and West Germany was third at ¥15,588 million or 7.9%.

(2) Exports

The total export value for the ISTA member nations in 1986 was ¥383,056 million. This was ¥107,869 million, or 39.2%, above the 1983 output level.

Ranking each country by the value of its exports, Japan was first at ¥109,795 million, which was an increase of ¥45,246 million, or 70.1%, over its 1983 level; second was West Germany at ¥68,793 million, a decrease of ¥2,324 million, or 3.3%, from 1983; next was the United States at ¥40,650 million, a decrease of ¥3,681 million, or 8.3%, from 1983; Holland displayed an enormous gain of ¥18,510 million, or 221.20%, over its 1983 level to ¥26,864 million; and Belgium had an export value of ¥23,621 million, thus increasing ¥12,273 million, or 108.2%, above its 1983 level (Table II-36).

(3) Imports

The total value of imports in 1986 for ISTA member nations was ¥258,322 million. This was a large increase of ¥116,276 million, or 81.9%, over the 1983 figure.

Table II-36. Exports (1986)

(Unit: Million Yen)

	Japan	West Germany	U.S.	Netherlands	Belgium	Italy	Switzerland	Canada [6]	France	U.K.	Spain	Portugal
Punch Press Dies	51,859 [4]	22,887	5,991	9,360	2,807	8,323	9,440	2,632	1,643 [1]	3,306	3,374	
Plastic and Rubber Molds	47,333 [3]	34,576	29,551	16,304	10,613 [2]	11,032	8,992	12,705	12,985	5,211	6,993 [2]	5,587 [1]
Diecast Dies	10,603 [5]	2,961	1,871	1,200	1,009	1,831	528	3,384	1,090	1,695	311	621 [1]
Jigs and Fittings		4,051	959		71		896	810		552		
Standard Tools and Parts		4,318 [1]	2,233		9,121		704	778		777		
TOTAL	109,795	68,793	40,605	26,864	23,621	21,186	20,560	20,309	15,718	11,541	10,698	6,208

	Sweden	Denmark	Finland
Punch Press Dies	2,024	432	38
Plastic and Rubber Molds	1,175	2,368	787
Diecast Dies	105	128	69
Jigs and Fittings			22
Standard Tools and Parts			10
TOTAL	3,304	2,928	926

GRAND TOTAL 383,056

NOTE:
1. Estimate
2. Including tire molds.
3. Including inorganic material molds.
4. Including casting molds.
5. Including other casting molds.
6. 1985 figures.

Ranked by country, the United States was first at ¥75,909 million, displaying a marked increase of ¥41,153 million, or 118.4%, from 1983. Second was West Germany at ¥42,143 million, an increase of ¥5,987 million, or 16.6%, from 1983. Next was Holland at ¥33,792 million, a large increase of ¥23,928 million, or 242.6%, over 1983. Finally, France had an import value of ¥20,024 million, a significant increase of ¥776 million, or 67.6%, over 1983 (Table II-37).

(4) Trade of NIES

Brief mention shall be made of mold and die import and export activities of the Asian NIES, which are not members of the ISTA but are growing in the mold and die industry. A detailed description will be given in a separate section later.

According to 1985 statistics from the Korean National Tax Administration, exports of molds and dies from Korea in 1984 totalled US$16.9 million, an increase of 13.9% from the previous year. Since export levels of molds and dies in the first half of 1988 reached US$10.474 million, there appears to be a high possibility of attaining the government's goal of US$20 million for the year. Along with the recovery in prosperity, imports increased rapidly and reached US$48.61 million in 1984.

Despite the fact that mold and die imports into Taiwan increased significantly in 1986 from 540 million yuan (approximately ¥2.47 billion) to 1,320 million yuan (approximately ¥6 billion), exports still grew over three times from 500 million yuan (approximately ¥2.3 billion), to 1,620 million yuan (approximately ¥7.4 billion).

Twenty to 25% of all production in Hong Kong goes toward exports. In 1986, export value was HK$469.5 million, or a 46% increase over the 1985 value. Export destinations include China, the United States, Japan, and neighboring Asian countries. Import value was almost the same as export value.

According to Singapore's industrial statistics for 1982, 6,529,000 Singapore Dollars in molds and dies were exported primarily to ASEAN nations, beginning with Malaysia. Imports totalled 38,479,000 Singapore Dollars.

(5) The Outlook for the International Division of Labor in the Mold and Die Industry

Next is a look at trade values in order to determine to what extent a horizontal division of labor had advanced among the major nations in the mold and die industry. Table II-38 shows the "Horizontal Division of Labor of Main Countries in 1986." A high degree of horizontal division of labor exists in the countries with large numbers.

Table II-37. Imports (1986)

(Unit: Million Yen)

	U.S.	West Germany	Netherlands	Belgium	France	U.K.	Canada [5]	Spain	Sweden [5]	Japan	Italy	Denmark
Punch and Press Dies	11,169	12,307	8,176	7,028	4,168 [1]	3,183	4,454	1,316	1,894		1,489	864
Plastic and Rubber Molds	50,770	22,015	23,472	6,867 [2]	14,040	10,371	2,336	7,503 [2]	3,374	4,623 [3]	1,973	2,384
Diecast Dies	3,096	3,700	2,144	916	1,816	1,825	532	228	467	426 [4]	383	112
Jigs and Fittings	5,813	1,557		166		879	3,949					
Standard Tools and Parts	5,061	2,564 [1]		9,030		2,553	4,404					
TOTAL	75,909	42,143	33,792	24,007	20,024	18,811	15,675	9,047	5,735	5,049	3,843	3,360

	Finland	Portugal	Switzerland
Punch and Press Dies	94		
Plastic and Rubber Molds	504		
Diecast Dies	10		
Jigs and Fittings	13		
Standard Tools and Parts	306		
TOTAL	927	-	-

GRAND TOTAL 258,322

NOTE:
1. Estimate
2. Including tire molds.
3. Including glass molds.
4. Including other casting molds.
5. 1985 figures.

Table II-38. Horizontal Division of Labor of Main Countries in 1986

(Unit: Million Yen)

	U.S.	West Germany	Netherlands	Belgium	France	U.K.	Canada	Spain	Sweden	Japan	Italy	Denmark	Finland	Portugal	Switzerland
Punch and Press Dies	69.8	69.9	93.2	57.1	56.5	98.1	74.3	71.9	96.7	0	30.4	66.7	57.6	-	-
Plastic and Rubber Molds	73.6	77.8	82.0	78.6	96.1	66.9	31.1	96.5	51.7	17.8	30.3	99.7	78.1	-	-
Diecast Dies	75.3	88.9	71.8	95.2	75.0	96.3	28.1	81.6	36.7	7.7	34.6	93.3	25.3	-	-
Jigs and Fittings	28.3	55.5	-	64.4	0	77.4	34.0	-	-	-	-	-	74.3	-	-
Standard Tools and Parts	61.2	74.5	-	99.5	0	46.7	30.0	-	-	-	-	-	6.3	-	-
TOTAL	69.7	76.0	88.6	99.2	88.0	76.0	87.1	91.8	73.1	8.8	30.7	93.1	99.9	-	-

Note: 1. Horizontal division of labor is expressed by $(1 - \frac{\text{Exports - Imports}}{\text{Exports + Imports}}) \times 100$.

2. Exports and imports are according to Tables II-36 and II-37.
3. - mark indicates statistics not yet reported or unavailable.

Accordingly, the highest degree exists in Finland, which registered 99.9; next was Belgium at 99.2; Denmark at 93.1; and Spain at 91.8. On the other hand, Japan had the smallest number, 8.8; Italy next at 30.7; then the United States at 69.7. From this information, it can be concluded that an advanced degree of horizontal division of labor exists mainly in a few of the European countries. Despite Japan's quick development in recent years in the horizontal division of labor, due in part to both pressure from the appreciation in the value of the yen and to an increase in imported goods, the division of labor in 1986 for the mold and die industry was exceedingly low.

Next, comparing this with Table II-39's "Horizontal Division of Labor of Major Countries in 1983", the degree of division of labor in the United States, Holland, France, Great Britain, and Italy is decreasing, but the overall degree of horizontal division of labor for all countries is advancing, as is indicated by the number for all countries mentioned earlier, which was 84.1 in 1986 and 68.1 in 1983.

Table II-40 shows the export and import coefficients in relation to trade scale.

In 1986, Portugal had the largest export coefficient of 0.970; next was Holland at 0.701; then Belgium at 0.643; Canada at 0.552; and Sweden at 0.519. The lowest coefficients belonged to the United States at 0.043, then Finland at 0.090, with Japan at 0.138. The values of exports from Japan and the United States were high, but because production values were high, their import coefficients were low. Comparing this to 1983 figures in Table II-41, the coefficients of the United States, West Germany, Holland, France, and Great Britain decreased, and those of Belgium, Sweden, Japan, Italy, and Finland increased. Excluding those countries for which statistics were lacking, the coefficient for all countries was 0.192 in 1986 and 0.140 in 1983, thus showing a growing trend overall.

The largest importing coefficient belonged to Sweden at 0.901; then Holland at 0.882; Belgium at 0.643; Canada at 0.426; and Great Britain at 0.300. In contrast, the lowest belonged to Japan at 0.013; then Italy at 0.042; and the United States at 0.081. Comparing this to 1983 levels and excluding Denmark and Switzerland, which lacked statistics, and Canada and Portugal, which were not ISTA members, import coefficients decreased in all the countries except the United States and Italy. However, again excluding Denmark, Switzerland, Canada, and Portugal, the import coefficients for all countries combined rose from 0.079 in 1983 to 0.132 in 1986.

Next is a comparison of growth and decline in imports and exports in each country between 1983 and 1986.

In this area, the United States and West Germany showed decreases of -8.3% and -3.2%, respectively, in exports. The other countries showed increases in the following order: Sweden, 375.4%; Holland, 172.3%; Belgium, 108.2%; Japan,70.1%; Denmark,

Table II-39. Horizontal Division of Labor of Main Countries in 1983

(Unit: Million Yen)

	U.S.	West Germany	Netherlands	Belgium	France	U.K.	Spain	Sweden	Japan	Italy	Denmark	Finland	Switzerland
Punch and Press Dies	87.7	56.8	86.9	64.9		87.8	29.7	42.7	-	49.3	49.0	52.3	-
Plastic and Rubber Molds	87.7	75.4	96.9	72.7	99.0	75.4	90.1	66.2	-	43.6	99.7	53.0	-
Diecast Dies	87.7	90.5	62.7	98.9	83.7	95.7	49.9		-	31.0	56.3	0	-
Jigs and Fittings	89.1	50.1		70.5		69.2			-	-			-
Standard Tools and Parts	87.7	77.7				83.3		70.6	-	-		88.4	-
TOTAL	87.9	67.4	91.8	95.8	97.4	85.6	64.3	62.8	11.6	44.6	89.3	88.6	-

Note: 1. Horizontal division of labor is expressed by $\left(1 - \frac{\text{Exports - Imports}}{\text{Exports + Imports}}\right) \times 100$.

2. Exports and imports are according to Tables II-42.
3. - mark indicates statistics not yet reported or unavailable.

Table II-40. Coefficient of Exports and Imports of Main Countries in 1986

(Unit: Million Yen)

	U.S.	West Germany	Netherlands	Belgium	France	U.K.	Canada	Spain	Sweden	Japan	Italy	Denmark	Finland	Portugal	Switzerland
Export Coefficient	0.043	0.330	0.701	0.643	0.233	0.184	0.552	0.196	0.519	0.138	0.232	-	0.090	0.970	0.436
Import Coefficient	0.081	0.112	0.882	0.653	0.296	0.300	0.426	0.166	0.901	0.013	0.042	-	0.090	-	-

Note: 1. Export coefficient is Export value/Production value.
2. Import coefficient is Import value/Production value.
3. - mark indicates statistics not yet reported or unavailable.

Table II-41. Coefficient of Exports and Imports of Main Countries in 1983

(Unit: Million Yen)

	U.S.	West Germany	Netherlands	Belgium	France	U.K.	Spain	Sweden	Japan	Italy	Denmark	Finland	Switzerland
Export Coefficient	0.045	0.387	0.863	0.634	0.286	0.263	-	0.022	0.200	0.193	0.182	0.068	-
Import Coefficient	0.035	0.197	1.017	0.690	0.301	0.351	-	0.049	0.012	0.055	0.225	0.054	-

Note: 1. Export coefficient is Export value/Production value.
2. Import coefficient is Import value/Production value.
3. - mark indicates statistics not yet reported or unavaiabale.

Table II-42. Comparison of Imports and Exports by Country in 1983/1986

(Unit: Million Yen)

	U.S.	FRG	Netherlands	Belgium	France	U.K.	Spain	Sweden	Japan	Italy	Denmark	Finland	TOTAL
1983 Exports	44,286	71,117	9,864	11,348	11,698	14,572	7,624	695	64,549	17,765	1,901	765	256,175
1986 Exports	40,605	68,793	26,864	23,621	15,718	11,541	10,698	3,304	109,795	21,186	2,928	926	335,979
Growth Rate (%)	-8.3	-3.3	172.3	108.2	34.4	26.3	40.3	375.4	70.1	19.3	54.0	21.0	31.2
1983 Imports	34,756	36,156	9,864	12,343	12,318	19,455	3,612	1,519	3,961	5,097	2,357	608	144,046
1986 Imports	75,909	42,143	33,792	24,007	20,024	18,811	9,047	5,735	5,049	3,843	3,360	927	242,647
Growth Rate (%)	118.4	16.6	242.6	94.5	95.0	-3.3	150.5	277.6	27.5	-24.6	42.6	52.5	68.5

Source: Materials of International Special Tooling Association

54.0%; Spain, 40.3%; France, 34.4%; Great Britain, 26.3%; Finland, 21.0%; and Italy, 19.3%. The overall growth rate for all countries studied was 31.2%.

For imports, on the other hand, Great Britain and Italy showed respective decreases of -3.3% and -24.6%. The increases occurred in the following order: Sweden, 277.6%; Holland, 242.6%; Spain, 150.5%; the United States, 118.4%; France, 95.0%; Belgium, 94.5%; Finland, 52.5%; Denmark, 42.6%; Japan, 27.5%; and West Germany, 16.6%. The overall growth rate for all countries studied was 68.5%.

It is said that the mold and die industry is structured so that the manufacturers locate themselves in the vicinity of their customers; however, imports and exports of molds and dies are increasing. Looking at the position of the major mold and die producing countries of the world, it is possible to say that an international horizontal division of labor is advancing based on the existence of the following: 1) A change toward horizontal division of labor within those countries; 2) A greater reliance on imports and exports in production; and 3) A trend toward increase in the absolute value of imports and exports.

2-3-2. The Status and an Overview of the Mold and Die Exports from Thailand

1) Mold and die exports from Thailand are growing rapidly. As shown in Table II-43, export values reached 76.69 million baht in 1986, up from 11.52 million baht in 1979. The average annual growth rate was 31.1%. During this period, however, the growth rate fluctuated. There was a 23.1% decrease in 1980 from the previous year, but a 71.6% increase in 1981. In 1982, there was another increase of 90.9%, but in 1983, there was a 26.7% decrease. The growth rate then increased 40.6% in 1984, 43.0% in 1985, and 79.2% in 1986.

Among the exports, there are few press dies, dies for wire drawing, or extrusion dies. Most are molds and dies for metals and metallic carbides or molds and dies for non-metals. Molds and dies for metals and metallic carbides are used for casting and die casting, and molds and dies for non-metals are used for rubber, plastics, and glass. Of the total export value in 1986, 76.69 million baht, one-third was accounted for by molds and dies for metals and metallic carbides, and the other two-thirds by dies and molds for non-metals.

There is large variation among the countries to which molds and dies are exported. According to Table II-44, molds and dies for metals and metallic carbides were exported to 16 countries or regions, and those for non-metals were exported to 31 countries or regions. The main countries for exports of molds and dies for metals and metallic carbides were Malaysia, with 9.7 million baht, or 38.77% of the total value; Australia, with 5.94 million baht, or 23.7%; Switzerland, with 3.59 million baht, or 14.3%; Hong Kong, with 1.74 million, or 7%; and Japan, with 1.334 million baht, or 5.3%. For molds and dies for non-metals, exports to Indonesia had the greatest value at 13.09 million baht, or 25.4% of the total value; then Malaysia, with 10.037 million baht, or 19.4%; Singapore, with 8.88 million baht, or 17.00%; Pakistan, with 3.666 million baht, or 7.4%; Japan, with 3.319 million baht, or 6.4%; and Hong Kong, with 3.23 million baht, or 6.3%. (The above figures are for 1986.).

2) According to trade statistics also, exports of molds and dies are increasing. In a questionnaire survey given to 60 companies by MIDI in 1987, 9 companies responded that they were exporting molds and dies. In 1983, there were only 4 such companies.

Although there were not many enterprises exporting molds and dies in the survey given to the manufacturers, those that were exporting were internal departments in companies related to the automobile industry or mold and die manufacturers related to the automobile industry. For example, company H produces molds and dies for metal sheets

Table II-43. Exports of Molds and Dies by Type

(Unit: Bahts)

	Item		1979	1980	1981	1982	1983	1984	1985	1986
1.	Press Dis etc. [CCCN 820521]	Value	4,040	141,059	-	-	1,148	-	7,398	6,740
		Growth Rate (%)	-	6,814.6	-100	-	-	-100	-	-8.9
2.	Dies for Wire Drawing, Extrusion [CCCN 820528]	Value	-	-	-	-	133,882	-	-	41,053
		Growth Rate (%)	-	-	-	-	-	-100	-	-
3.	Molds for Metal and Metallic Carbides [CCCN 846002]	Value	3,276,592	1,956,200	3,333,542	3,049,239	5,091,995	2,294,433	2,261,968	25,019,625
		Growth Rate (%)	-	-40.3	70.4	-8.5	67.0	-54.9	-1.4	1,008.1
4.	Molds for Nonmetals [CCCN 846003]	Value	8,261,730	6,771,230	11,883,848	25,997,890	16,066,241	27,642,351	40,532,708	51,622,634
		Growth Rate (%)	-	-18.0	75.5	118.8	-38.2	72.1	46.6	27.4
	TOTAL	Value	11,525,362	8,868,489	15,217,390	29,047,129	21,293,268	29,936,784	42,802,074	76,690,052
		Growth Rate (%)	-	-23.1	71.6	90.9	-26.7	40.6	43.0	79.2

Source: Customs clearance statistics

for company T's medium and large trucks. It is then exporting to company T's factories in Indonesia, South Africa, and Taiwan. Similarly, company S produces molds and dies for company T, and it is exporting 170 molds and dies per year through company T. Company S also independently received an order from China in March 1988 for 240 molds and dies. One Japanese-affiliated automobile parts manufacturer is exporting to its own enterprise group's factories in Malaysia, Singapore, and Australia.

3) If molds and dies are considered goods that have a strong connection with the customer, then the exports that are occurring now are being realized on the basis of relationships between the manufacturer and customer. This type of exporting will likely continue. Furthermore, intra-group transactions will increase in cases in which enterprises and enterprise groups that are related to automobile and household electrical goods and to foreign capital are integrated into the parent company's supply and demand network. There will then be possibilities for increases in mold and die exports.

Table II-44. Exports of Molds and Dies of Thailand by Destination

Item	Country	1984 Q'ty	1984 Bahts	1985 Q'ty	1985 Bahts	1986 Q'ty	1986 Bahts	1986 Share (%)
1. Press Dies Etc.	LAO PEOPLES	- kg	-	- kg		2 kg	6,740	100.0
[CCCN 820521]	SINGAPORE	-	-	130	7,398	-	-	-
	Total	-	-	130 kg	7,398	2 kg	6,740	100.0
2. Dies for Wire Drawing,	MALAYSIA	- kg	-	-	-	533 kg	29,860	72.7
Extrusion	U.S.A.	-	-	-	-	160	11,193	27.3
[CCCN 820528]	Total	- kg	-	- kg	-	693 kg	41,053	100.0
3. Molds for Metal and	AUSTRALIA	- Unit	-	- Unit	-	11 Unit	5,937,523	23.7
Metallic Carbides	SWITZERLAND	-	-	-	-	3	3,589,650	14.3
[CCCN 846002]	CHINA	-	-	-	-	29	318,675	1.3
	HONG KONG	2	33,283	3	15,874	9	1,739,677	7.0
	INDONESIA	-	-	-	-	17	1,333,616	5.3
	JAPAN	1	308,814	-	-	3	2,384,555	9.5
	MALAYSIA	160	1,345,517	19	640,878	58	9,697,375	38.7
	NEPAL	-	-	-	-	90	7,960	-
	SINGAPORE	13	450,064	50	1,412,500	6	10,594	-
	FRANCE	-	-	1	4,821	-	-	-
	JORDAN	-	-	2	110,880	-	-	-
	SRI-LANKA	-	-	6	46,316	-	-	-
	SWEDEN	-	-	20	17,075	-	-	-
	U.S.A.	26	4,465	60	13,624	-	-	-
	U.K.	500	47,918	-	-	-	-	-
	TAIWAN	15	104,372	-	-	-	-	-
	Total	717 Unit	2,294,433	161 Unit	2,261,968	226 Unit	25,019,625	100.0

4.	Molds for Nonmetals [CCCN 846003]	BANGLADESH	680 kg	145,368	1,416 kg	235,187	190 kg	20,805	-
		BRUNEI	7	1,991	-	-	3,250	131,355	0.3
		HONG KONG	13,069	1,572,868	6,259	500,611	54,009	3,229,719	6.3
		INDIA	4,450	614,137	36,883	9,892,472	1,300	106,475	0.2
		INDONESIA	18,419	1,054,614	5,604	1,240,823	90,643	13,090,943	25.4
		JAPAN	6,374	1,344,541	26,588	8,959,338	1,228	3,319,333	6.4
		MALAYSIA	35,830	3,759,680	60,409	7,427,148	105,276	10,036,523	19.4
		NEPAL	161	84,057	336	198,973	-	-	-
		PAKISTAN	5,071	1,044,742	6,797	742,867	29,064	3,814,475	7.4
		PHILIPPINES	8,256	712,657	8,431	609,076	9,207	3,665,575	7.1
		SAUDI ARABIA	850	23,948	10,632	247,770	-	-	-
		SINGAPORE	105,534	8,892,558	16,011	2,469,209	42,381	8,800,111	17.0
		SRI-LANKA	183	270,747	803	385,518	3,092	770,144	1.5
		TAIWAN	2,787	267,517	2,761	429,709	2,589	1,037,782	2.0
		ITALY	146	3,435	8	8,676	-	-	-
		SPAIN	200	17,231	-	-	-	-	-
		SWEDEN	100	17,767	-	-	-	-	-
		U.K.	3,565	5,956,483	726	1,165,968	-	-	-
		U.S.A.	1,214	1,766,862	2,481	3,973,627	2,967	655,106	1.3
		MORROCCO	446	63,526	-	-	-	-	-
		AUSTRALIA	198	27,622	8,402	541,823	-	-	-
		CANADA	-	-	6	56,959	62	1,942	-
		CHINA	-	-	93	4,245	4,931	1,059,563	2.1
		JORDAN	-	-	2,533	1,232,777	1,400	65,750	0.1
		LAO PEOPLES	-	-	638	112,639	86	89,587	0.2
		LUXEMBURG	-	-	1,375	84,052	-	-	-
		NORWAY	-	-	273	13,235	-	-	-
		FGR	-	-	-	-	7,940	1,184,017	2.3
		NETHERLANDS	-	-	-	-	381	19,527	-
		NEW ZEALAND	-	-	-	-	208	79,214	0.2
		PORTUGAL	-	-	-	-	1,415	374,688	0.8
		Total	207,540 kg	27,642,351	199,467 kg	40,532,708	361,619 kg	51,622,634	100.0
		GRAND TOTAL		29,936,784		42,802,074		76,690,052	

Source: Customs Department

3. Mold and Die Industry of Asian NIES and Japan

3-1. South Korean Mold and Die Industry

(1) Development

At the end of the Second World War, technology for mold 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 molds 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 mold and die industry began to develop, and this has provided the base for today's mold 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 mold 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 mold 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 mold 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 os 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 Mold 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 molds for plastic 27%. Many of the companies which produce press dies are involved in other production as well, whereas most of those producing molds for plastic specialize in such molds.

Ratio of Specialization	Less than 50%	50-99%	100%
Manufacturers of Press Dies	194	18	37
Manufacturers of Plastic Molds	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 molds 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%
	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 molds 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 molds and have 20% produced outside.

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

(Source: Industrial Research Institute)

6) As for equipment, the majority of mold 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 spark 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 spark machines (Source: same as above).

7) The most important factor in the manufacture of molds 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 molds 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 molds. (Source: Medium and Small Enterprise Promotion Corporation)

(3) Demand and Supply Trends

1) Although the demand and supply of molds and dies in South Korea fell below the 1979 level in 1980 and 1981 as a result of the domestic slump recorded during those 2 years, business conditions recovered in 1982 so that a 37.9% increase in molds and dies was recorded that year. Since then there has been a steady increase and the value of molds and dies easily cleared the 1 trillion won mark in 1984. The level in 1983 exceeded that of 1979. (Table II-45)

2) Production fared the same as the trend in demand and supply, and in 1984 reached 1 trillion won. (Table II-45)

3) There are no production statistics for molds and dies by type. According to shipping figures put out by the Economic Planning Institute in 1984, out of 1.123 trillion won, plastic molds accounted for the largest value with 31.9%, followed by press dies (21.1%), casting molds (4.9%), and die cast molds (3.1%). (Table II-46)

(4) Exports and Imports

1) Exports

As shown in Table II-45, from a value of 4.2 billion won in 1979, exports of Korean molds and dies increased sharply to 7.29 billion won in 1982, and then 12.75 billion won in 1984.

Concerning the different types of molds, rubber and plastic molds comprise the larger part, and in 1983 accounted for 46.8% of mold and die exports. (Table II-47) As for the country of destination, the most went to Japan, followed by the United States and then Malaysia. (Table II-48)

2) Imports

Imports increased sharply from a value of 14.62 billion won in 1979 to 24.14 billion won in 1980. Although they slumped for a while after that, they began to increase again with the recovery of the economy and in 1984 were worth 35.27 billion won.(Table II-45) However, due to the increase in overall production, the ratio of dependence on imports compared to total demand decreased, and in 1984 accounted for 25.2% of total demand.

Table II-45. Trends in Supply and Demand of Molds and Dies in South Korea

(Unit: Million won)

Item	Year	1979	1980	1981	1982	1983	1984
Supply	Production	50,210	24,865	25,306	37,370	67,508	104,496
	Imports	14,621	24,140	13,373	15,923	25,269	35,207
Total		64,831	49,005	38,679	53,293	92,777	139,703
Demand	Domestic demand	60,539	44,413	34,365	46,008	81,477	127,463
	Exports	4,292	4,592	4,314	7,285	11,300	12,240
Import Reliance		22.6	49.3	34.6	29.2	27.2	25.2
Export Ratio		8.5	18.5	17.0	19.5	16.7	11.7

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

Table II-46. Shipments of Molds and Dies by Type

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

Source: Economic Planning Agency, Industrial Statistics (1984)

Table II-47. Exports of Molds and Dies by Type

(Unit: US$1,000)

	1979	1980	1981	1982	1983	Share
Dies	664	1,065	145	153	215	2.1
Metal Forging Molds	215	109	392	638	1,043	10.3
Molds for Metal and Metal Carbides	515	603	229	318	996	9.8
Glass Molds	79	41	47	-	435	4.3
Molds for Forming Mineral Materials	243	143	985	154	2,214	21.7
Rubber or Plastic Molds	4,440	1,888	1,428	3,749	4,756	46.8
Others	2,366	2,322	1,115	1,414	511	5.0
Total	8,522	6,172	4,341	6,426	10,160	100.0

Source: Korean Trader's Association

Table II-48. Trends in Exports of Molds and Dies

(Unit: US$1,000)

	Exports	Main Export Destinatioons
1979	8,521	Japan(49.4), Sudan(21.5), U.S.(9.1), Saudi Arabia(5.9)
1980	6,173	Japan(61.6), Saudi Arabia(12.3), U.S.(10.4)
1981	4,341	Japan(27.1), Saudi Arabia(20.3), U.S.(8.3), Libya(12.0)
1982	6,426	Saudi Arabia(26.9), Malaysia(19.6), Japan(14.7), U.S.(8.8)
1983	10,160	Japan(45.8), U.S.(12.5), Malaysia(10.7), Libya(9.9)

Source: Korean Trader's Association

As for the types of molds and dies which are imported, molds for plastic and rubber comprise the larger part, and accounted for 46.2% of imports in 1983. They were followed by dies which accounted for 27.9% of imports.(Table II-49) The main countries from which they were imported are Japan, the United States, West Germany and Canada. (Table II-50)

(5) Industries Using Molds and Dies

Though there does not appear to be any data on the different types of industries which use molds and dies, experts within industry generally agree that the transportation and machinery industries (electric, electronic, and automobile industries) account for the larger part of mold and die users.(Table II-51)

According to a survey conducted by the South Korean Industry Research Institute (KIET) in 1984, the major users of molds and dies produced 58% of their requirements in-house and depended on outside contracting or imports for the remaining 42%. (Table II-52)

(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 mold and die industry. The following have being used as objective data: A- equipment; B- precision and performance of molds; C- processing and design technology; D- management know-how for production stages etc; and E- personnel.

Table II-49. Imports of Molds and Dies by Type

(Unit: US$1,000)

	1979	1980	1981	1982	1983	Share
Dies	8,219	1,288	3,672	3,508	8,363	27.9
Metal Forging Molds	1,413	2,400	806	507	2,262	7.5
Molds for Metal and Metal Carbides	4,917	3,025	2,088	1,732	3,479	11.6
Glass Molds	1,138	373	211	1,672	1,615	5.4
Molds for Forming Mineral Materials	319	506	87	1,334	214	0.7
Rubber or Plastic Molds	12,554	11,095	10,287	10,498	13,933	46.4
Others	850	1,072	895	741	149	0.5
Total	29,409	19,758	18,047	19,991	30,014	100.0

Source: Korean Trader's Association

Table II-50. Trends in Imports of Molds and Dies

(Unit: US$1,000)

	Exports	Main Export Destinatioons
1979	29,409	Japan(89.1), U.S.(5.9), West Germany(1.7)
1980	19,758	Japan(74.1), U.S.(11.4), West Germany(9.7)
1981	18,047	Japan(74.3), U.S.(11.7), West Germany(6.6)
1982	19,991	Japan(75.9), U.S.(18.5)
1983	30,014	Japan(82.0), U.S.(12.0), Canada(1.5)

Source: Korean Trader's Association

Table II-51. Industries Using Molds and Dies

Industry	Ratio of Total Turnover
Electric and Electronic Industries (Includes Household Appliances)	35%
Transportation Machinery, Automobiles	30%
Metal Processing Industry	15%
Other Industries	20%

(Source:JETRO Seoul Office)

Table II-52. Method of Procuring Molds and Dies byCompanies Using Same

(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 Molds	100.0	26.5	57.4	16.0
Diecast Molds	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

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 molds and dies possessed a relatively large number of vertical milling machines, electric spark machines, mold grinding lathes, radial drilling machines, and engraving machines. (Table II-53)

Generally speaking, mold 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 spark machines, CAD, and 3-dimensional measuring machines, the majority of manufacturers mainly use specialist machines.

2) Precision and Performance

Table II-54 provides a comparison of the quality levels of Japan and Korea, and as is shown, Korean-made molds 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 molds and dies is only half of that of Japanese-made products. Korean-made molds are also of a lower level than Japanese products in regard to appearance and surface treatment.

3) Processing and Design Technology

• Design technology

The design technology of Korean mold and die manufacturers is such that although the producers can design molds 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 mold and die manufacturers depend on specialist machine tools and are behind in processing technology and, as already mentioned, the level of precision

Table II-53. 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	Grinder	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

Table II-54. Comparison of Quality of Molds 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.

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 molds 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 mold 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 mold and die industry primarily because the individual companies themselves do not have such figures.

According to the Korean mold, die, and tools industry union, as of the end of 1982 the level of education received by 59% of employees working in the mold 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 II-55, 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 II-55. No. of Employees by Mold 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 Mold and Die Industry

1) Training of Technicians and Skilled Workers.

Since the end of the 1970s the Korean mold 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 mold 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 II-56.

II-56. Training Facilities for Mold and Die Engineers

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