II-2. Summary of Comprehensive Promotion Programmes Proposed

II-2-1. Castings

(1) Proposed Comprehensive Promotion Programmes

Various programmes corresponding to the measures for the development of the Malaysian casting industry were studied. In the end, the proposal was brought in the following programmes. Execution measures and schedules of the proposed programmes is shown in Table II.2-1.

Programme 1.	Expansion of Training and Education Programmes for Managers
Programme 2.	Development of Engineers and Technicians
Programme 3.	Greater Guidance in Quality Control
Programme 4.	Greater Activities by Foundry and Engineering Industries Associations
Programme 5.	Promotion of the Construction Plan for Foundry and Engineering Industrial Parks
Programme 6.	Expansion of Financing Scheme for the Development of Small and Medium Scale Enterprises
Programme 7.	Attraction of Investment and Promotion of Technical Tie-up
Programme 8.	Increased Export Promotion Activities

(2) Review of Priority Programmes

It is desirable that the programmes proposed for each industry in the preceding section be fully and intensively implemented. However, the reality of the situation is such that due to various kinds of restrictions, such as limited funds and staff, an order of priority has to be set for implementing these programmes.

Because none of the programmes presented here have been proposed as a result of carrying out adequate feasibility studies, it is not possible, for example, to set the order of priority on the basis of actual figures such as the FIRR which have been calculated for amounts to be invested and their effects. Results of priority programmes identification are given in Table II.2-2.

Fig.II.2-1 Process of Formulation of Comprehensive Programmes for Development of Casting Industry

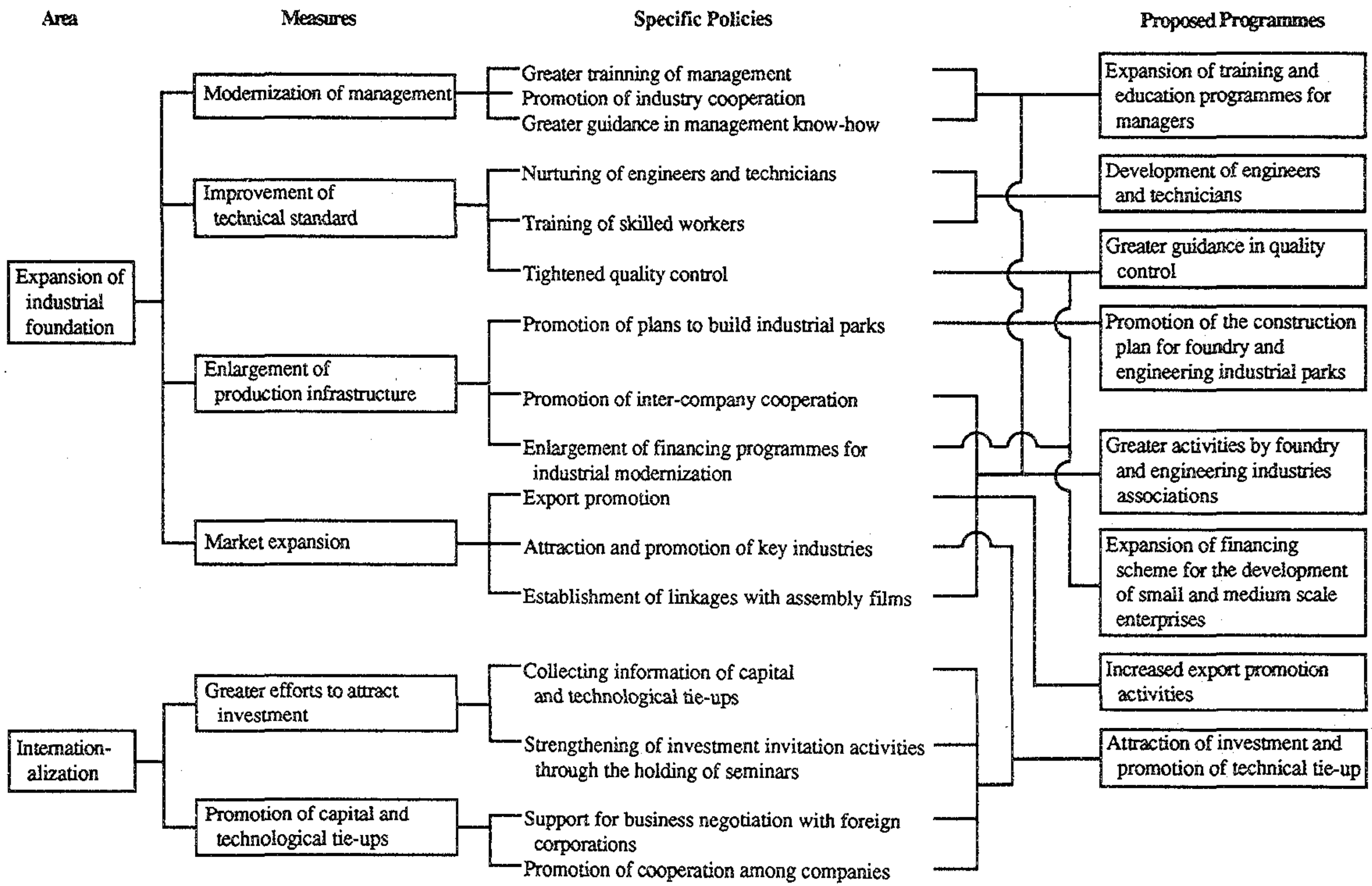


Table II. 2-1 Execution Measures and Schedules of the Proposed Programmes (Casting Industry)

Name of the Programme and its Objectives	Contents of the Programme	Measures to be taken by Malaysian side	Execution Measures and their Schedule			
			Measures	Execution Schedules		
				Immediately	At an early stage	After Preparation
1. Expansion of training and education programmes for managers – It is urgent to conduct the education of modernized management techniques for the development of the industry	1) Under the sponsorship of NPC and industry associations – Holding seminars – Traveling guidance – Consulting services 2) Overseas training of top management 3) Collection and dissemination of information on modernized production and management techniques	– Support of NPC, Industry Association activities, etc.	Invitation of experts Overseas training	O	 O	
2. Development of engineers and technicians – To rationalize the production system at the many plants presently relying upon operator experience and intuition by providing engineers with practical training in the latest management systems and production technologies	1) Training of engineers through – Holding seminars – In-house training – Practical training in technical courses 2) Overseas training 3) Collection and dissemination of information	– Support to promotion of scheme for National Technical Development Centre – Expansion of advanced technology courses – Implementation of traveling guidance	Implementation of a F/S on Development Centre Invitation of experts Overseas training	 O	O O	
3. Greater guidance in quality control – To improve product quality, productivity and competitive power QC activities should be strengthened	1) The holding of QC seminars of experts sponsored or co-sponsored by SIRIM, NPC and Industrial Associations 2) The holding of QC workshops in individual companies	– Expansion of SIRIM and other related organizations' activities	Invitation of experts Overseas training	O	 O	

Name of the Programme and its Objectives	Contents of the Programme	Measures to be taken by Malaysian side	Execution Measures and their Schedule			
			Measures	Execution Schedules		
				Imme-diately	At an early stage	After Prepa-ration
	3) Strengthening of the national standards system and promotion of company standardization by SIRIM					
4. Greater activities by foundry and engineering industries associations – To strengthen the organization and activities and thereby increase the exchange of technical and management information between member corporations – To increase exchange with overseas companies and industry association	1) Collection of information concerning production, technologies and materials 2) Collection of information concerning domestic and foreign markets and demands 3) The holding of seminars on quality and technology 4) Examination on Common Facility Centre activities	– Examination on expansion of Industrial Association activities – Collection and dissemination of information – The holding of seminars – Increase of exchanges with overseas companies and industrial association	Invitation of experts Overseas training Dispatch of missions Expansion of activities to foreign mission	O	O	
5. Promotion of the construction plan for foundry and engineering industrial parks	1) Modernization of the plants and equipment at casting factories 2) Strengthening of Common Facility Centre activities in parks	– Promotion of plans to construct foumdy parks – Promotion of plans to set up Common Facility Centres	Invitation of experts Introducing equipment		O	O
6. Expansion of financing scheme for the development of small and medium scale enterprises – To facilitate the fund-raising required by Malaysia's small factories	1) Enlargement of the CGC loan guarantee scheme in order to facilitate access to public financial institutions by small businesses having difficulty in obtaining credit	– Implementation of the study on new credit systems	Invitation of experts Overseas training		O O	

Name of the Programme and its Objectives	Contents of the Programme	Measures to be taken by Malaysian side	Execution Measures and their Schedule			
			Measures	Execution Schedules		
				Imme-diately	At an early stage	After Prepa-ration
	2) Establishment of new credit systems to support fund-raising for modernization of production facilities by small manufacturers					
7. Attraction of investment and promotion of technical tie-up – To attract foreign casting companies to Malaysia in areas in which existing Malaysian casting companies lack necessary technology or experience	1) Information service for the invitation of investment – Compilation of guidebook by industry – Preparation of a directory of domestic factories 2) Dispatch of investment invitation mission 3) Strengthening of support and cooperation given to overseas missions 4) Provision of a service to match partners	– Collection of detailed information – Dispatch of PDT members – Strengthening of information service activities	Issue of guidebooks Information collection on potential investors		O O	
8. Increased export promotion activities – To break into overseas markets by the promotion of capital and technological tie-up with foreign corporation – To assist the export promotion efforts of local factories	1) Collection of foreign market and trade inquiry information 2) Dispatch of market study missions 3) Dispatch of export promotion missions	– Expansion of export promotion activities	Information collection on foreign markets Dispatch of missions			O O

Table II. 2-2 Results of Priority Programme Identification (Casting Industry)

	Expansion of Training and Education Programmes for Managers	Development of Engineers and Technicians	Greater Guidance in Quality Control	Greater Activities by Foundry and Engineering Industries Associations	Promotion of the Construction Plan for Foundry and Engineering Industrial Parks	Expansion of Financing Scheme for the Development of Small and Medium Scale Enterprises	Attraction of Investment and Promotion of Technical Tie-up	Increased Export Promotion Activities
1. Existence of established organizations in charge of the programme	Yes (NPC)	Yes (FTU, CIAST)	Yes (SIRIM)	Yes (MIDA, FOMFEIA)	Yes (MIDA, SEDC FOMFEIA)	Yes (CGC)	Yes (MIDA)	Yes (MEXPO)
2. Maturity level of the programme	Moderate	High	High	High	High	Moderate	Moderate	Low
3. Urgency of the needs of the programme	High	Moderate	High	High	High	High	High	Moderate
4. Scale of investment in the programme	Medium	Small	Medium	Medium	Large	Medium	Medium	Small
5. Level of direct impact	Great	Great	Great	Great	Great	Great	Great	Moderate
6. Necessity of outside assistance	Strong	Moderate	Strong	Strong	Moderate	Strong	Moderate	Moderate
Priority selection	A	B	A	A	A	A	B	B

Note: A: The programme is selected as a priority programme
B: The programme is given a secondary importance

II-2-2. Computers and Computer Peripherals

(1) Proposed Comprehensive Promotion Programmes

Based on the outcome of the study and what is assumed to be the most realistic scenario for development, a series of measures to realise the development of the computers & computer peripherals industry in Malaysia are proposed. The process of formulation of the comprehensive programmes is shown in Fig. II. 2-2.

The proposed execution measures and implementation schedules of these programmes are summarized and shown in Table II.2-3.

Programme 1.	Intensification of the Investment Promotion Organization's Activities
Programme 2.	Strengthening of Measures for the Development of Small and Medium-scale Manufacturing Enterprises
Programme 3.	Intensification of Export Promotion Activities
Programme 4.	Promotion of QC Activities
Programme 5.	Strengthening of Training of Skilled Workers
Programme 6.	Training of Electronics-related Engineers and Intensification of R&D Activities
Programme 7.	Expansion of Low Interest Rate Loan Scheme to Promote Supporting Industries

(2) Review of Priority Programmes

To develop the selected industries, it would be ideal if all of the comprehensive programmes proposed for the industry were quickly implemented with full effort. However, given the reality of the very tight limitations on both financial and human resources, it is necessary to give a rough priority ranking to each proposed programme.

Because sufficient feasibility studies were not possible for all of the programmes proposed in this study, a priority ranking of each programme could not be given using *strict criteria such as IRR (International Rate of Return) figures for each programme.* As an alternative, a priority ranking for each programme was determined through the rather subjective judgement of the Study Team which considered the six basic criteria. The results of an examination of priorities are shown in Table II.2-4.

Fig. II. 2-2 Process of Formulation of Comprehensive Programmes for Development of Computers and Computer Peripherals Industry

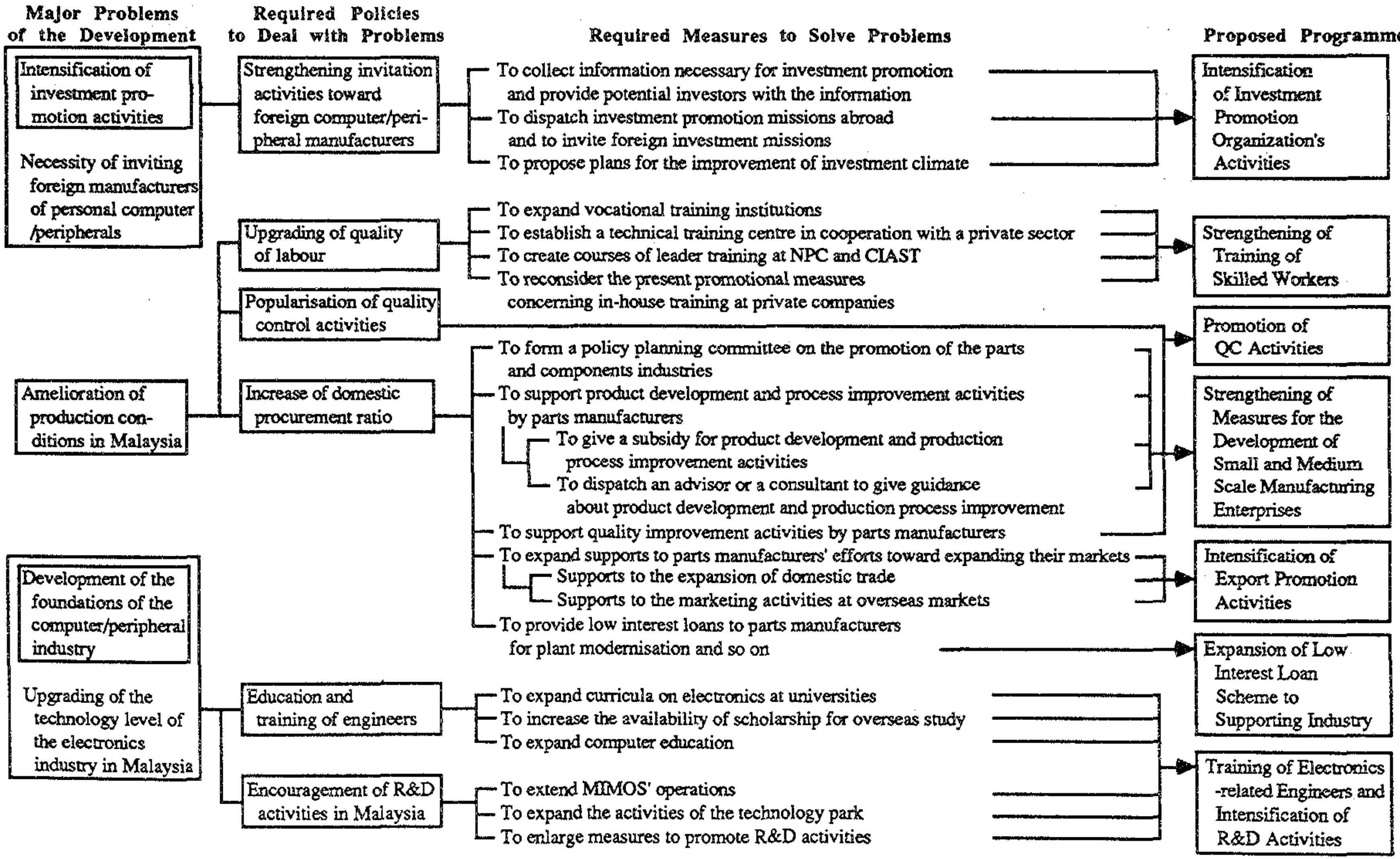


Table II. 2-3 Execution Measures and Schedules of the Proposed Programmes (Computers and Computer Peripherals Industry)

Name of the programme and its objectives	Contents of the programme	Measures to be taken by Malaysian side	Execution measures and their schedules			
			Measures	Execution schedules		
				Imme-diately	At an early date	After prepa-ration
1. Intensification of Investment Promotion Activities (Expansion of MIDA Activities) <Objectives> – Promotion of foreign investment in Malaysia – Promotion of technical tie-ups between foreign and Malaysian manufacturers	1) Information service for invitation of foreign investment – Compilation of guidebooks for each industry sector – Preparation of a directory of domestic parts suppliers 2) Dispatch of investment invitation missions 3) Strengthening of accommodation facilities for receiving investment missions 4) Matching of firms desiring tie-ups	– Collection of industry-specific information – Strengthening of linkages between MIDA and the MTI Small and Medium Industry Division – Creation of PDT teams for dispatch overseas – Strengthening of receiving facilities by industry and country – Listing of firms desiring tie-ups	Preparation of guidebooks Information collection Invitation of foreign experts Ad-hoc cooperation	O O O O		
2. Development Programme for Small and Medium-scale Manufacturers <Objectives> – Formulation of policies for the development of supporting industries and the coordination of activities at related organizations for that purpose – Visits to SMIs by experts for guidance in the areas of production technology, management, and marketing skills	1) Help for individual SMIs in improving production technology with the cooperation of foreign experts and staff from the MTI Small and Medium Scale Enterprises Unit, SIRIM, and other related organizations 2) Help for individual SMIs in improving management and marketing skills with the cooperation of foreign experts and staff from the MTI Small and Medium Industry Division, NPC, and	– Expansion of the MTI Small and Medium Scale Enterprises Unit – Appointment of instructors at SIRIM, etc. for touring guidance to individual companies – Appointment of instructors at NPC, MEXPO, etc. for touring guidance to individual companies	Invitation of foreign experts in production technology Invitation of foreign experts in management and marketing Invitation of foreign experts in SMI policy	O O O		

Name of the programe and its objectives	Contents of the programme	Measures to be taken by Malaysian side	Execution measures and their schedules			
			Measures	Execution schedules		
				Imme-diately	At an early date	After prepa-ration
	MEXPO 3) Creation of a policy and coordination section within the MTI Small and Medium Industry Division for coordination of the above activities and formulation of comprehensive policies for the development of SMIs					
3. Intensification of Export Promotion Activities (Expansion of MEXPO Activities) <Objective> – Support for the domestic and overseas marketing efforts of local parts manufacturers as part of the activities for development of supporting industries	1) Strengthening of MEXPO capabilities for the collection and distribution of marketing-related information – Strengthening of the inquiry service – Preparation of a directory of local parts manufacturers – Timely distribution of information to local companies 2) Invitation of foreign purchasing missions and sponsoring of exhibitions 3) Participation in overseas trade fairs	– Expansion of MEXPO staff and budget	Information collection Reception of missions from abroad Dispatch of missions	O O O		
4. Promotion of Quality Control Activities <Objectives> – Raising quality awareness	1) Invitation of quality control experts under the sponsorship of NPC and industry associations for the following activities:	– Greater support for NPC activities – Greater support for industry association activities	Invitation of foreign quality control experts Overseas training		O O	

Name of the programme and its objectives	Contents of the programme	Measures to be taken by Malaysian side	Execution measures and their schedules			
			Measures	Execution schedules		
				Imme-diately	At an early date	After prepa-ration
among these firms for the development of the local parts industry – Improving quality and productivity of exports by more active quality control efforts at plants	– Holding of seminars on quality control – Holding of quality control workshops at individual companies 2) Compilation of quality control manuals and distribution to local companies					
5. Strengthening of Training of Skilled workers <Objectives> – Resolution of the shortage of skilled labourers plaguing the electronics industry, improved standards in peripheral industries, and improvements in the quality of the investment environment	1) Expansion of vocational training schools, MARA, etc. – Enlargement of metal machining courses at the above institutions – Enlargement of electronics and electrical machinery engineering courses at the same	– Preparation of estimates of current curriculae, instructors, and facilities together with plans for expansion	Invitation of foreign experts Overseas training	O O		
	2) Creation of a joint public-private technical training center – Investigation of a joint technical training center such as the ones in Singapore and Thailand	– Creation of a committee to investigate related matters – Observation of similar facilities in other countries	Invitation of foreign experts Overseas training	O O		
	3) More active in-house training in the private sector	– Reexamination of existing incentives				

Name of the programe and its objectives	Contents of the programme	Measures to be taken by Malaysian side	Execution measures and their schedules			
			Measures	Execution schedules		
				Imme-diately	At an early date	After prepa-ration
6. Human Resources Development and R&D Expansion in the Fielf of Electronics <Objectives> – Training of engineers required by the electronics industry – Promotion of R&D activities by national research institutes	1) Support for private-sector R&D through electronics-related education at the university level and greater cooperation between industry and academia – Promotion of the USM Design Laboratory for Information Technology Scheme – Promotion of the UKM Engineering Application Centre Scheme 2) Expansion of MIMOS activities and accumulation of personnel and experience	– Promotion of the USM Design Laboratory for Information Technology Scheme – Promotion of the UKM Engineering Application Centre Scheme – Enlargement of the MIMOS staff and budget – Creation of a system for the overseas training of staff and the invitation of foreign experts	Invitation of foreign experts Introduction of facilities Invitation of foreign experts Introduction of facilities Invitation of foreign experts Overseas training		O O O O O O	
7. Expansion of Financing Schemes for the Development of Supporting Industries <Objective> – Provision of financial assistance to small and medium-scale parts manufacturers as part of the activities for development of supporting industries	1) Consideration of low-interest loan schemes for capital investment by small and medium-scale parts manufacturers via the utilization of existing credit programmes or the establishment of new funds for this purpose, drawing on the experiences of other nations	– Investigation and study on a new investment/financing system	Overseas training Invitation of foreign experts	O	O	

Table II. 2-4 Results of Priority Programme Identification (Computers and Computer Peripherals Industry)

	Intensification of Investment Promotion Activities (Expansion of MIDA Activities)	Development Programme for Small and Medium Scale Manufacturing Enterprises	Intensification of Export Promotion Activities	Promotion of Quality Control Activities	Strengthening of Training of Skilled Workers	Human Resources Development and R&D Expansion in the Field of Electronics	Financing Scheme for Development of Supporting Industries
1. Existence of established organizations in charge of the programme	Yes (MIDA)	Yes (MTI)	Yes (MEXPO)	Yes (NPC)	Yes (Vocational training school, MARA, etc.)	Yes (MIMOS, USM, UKM and others)	No
2. Maturity level of the programme	High (presently being supported)	High (plan already exist)	High (presently being supported)	Low	Moderate	Moderate (in planning stage)	Low
3. Urgency of the needs of the programme	High	High	Moderate	Low	High	Moderate	Moderate
4. Scale of investment in the programme	Medium	Medium	Medium	Small	Medium	Large	Large
5. Level of direct impact	Great	Great	Moderate	Moderate	Moderate	Moderate	Moderate
6. Necessity of outside assistance	Moderate	Strong	Moderate	Weak	Strong	Moderate	Moderate
Priority selection	A	A	B	B	A	B	B

Note: A: The programme is selected as a priority programme
B: The programme is given a secondary importance

III. Castings

III-1. Outline of the Casting Industry

III-1-1. Development of the Casting Industry

The Malaysian casting industry has grown together with the tin industry. The former industry began its existence relying on orders from the latter for repairs, parts, maintenance, machining, and welding, and the relationship has continued throughout the past 70 years.

The following diagram shows the relationship between tin production and the number of foundries in Malaysia against the backdrop of the international tin market environment. It can be seen how the ups and downs experienced by the tin industry during the ten years leading up to 1986 affected casting companies. For example, 1985 saw the collapse of the international tin accord, and in 1986 tin prices dropped more than 26%. During this year, 38 foundries ceased production.

International Market Environment		Tin production (1,000 tons)	No. of foundries
• Long-term supply shortage —> Rising tin prices			
	1975	64.4	220*
• Global economic recession			
• Rising tin prices —> Efforts by major buyers to develop substitutes			
• Increased production and new development by Brazil, Bolvia, and China			
• Release of tin inventory by the U.S.			
—> Collapse of world supply-demand balance	1984	41.3	120
—> Collapse of international accord and plummeting prices	1985	36.9	114
• Seven-country agreement to restrict production and limit exports	1986	29.1	76
• Economic recovery			
	1989	30.0	121

Source: Economic Report 1988/89, Survey on Malaysian Foundry Industry
* 1976 figures

As will be shown in the analysis of cast metal demand that will follow, the tin mining industry provided the largest single source of demand for Malaysia's casting industry in 1988, with other traditional industries such as palm oil, rubber, and timber also accounting for large shares.

Since 1987, however, despite only slight growth in tin production, the number of foundries in Malaysia has increased markedly. This is indication of the rapid deversification being undergone by the industry as a result of increased demand from new, modern industries.

III-1-2. Distribution and Scale of Production

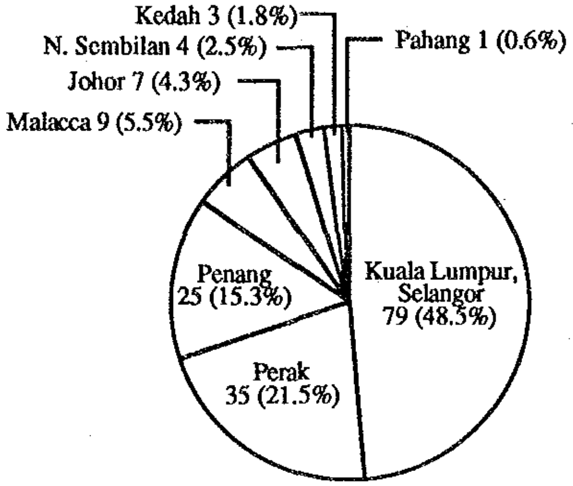
(1) Distribution of production

At the end of 1989, 121 foundries belonged to the Federation of Malaysian Foundry & Engineering Industries Association (FOMFEIA). There are no official figures as to the total number of foundries in Malaysia, including non-FOMFEIA facilities, but based on information gained from local industry sources during the present survey the figure is thought to number 163. In the current interviews and questionnaires, responses concerning production volume were obtained from 112 factories, 68.7% of the total. The distribution of production was determined based on these figures, and the total production volume in Malaysia was also measured.

1) Distribution of foundries by region

Of the 163 foundries, 48.5% were concentrated in Kuala Lumpur and Selangor. When added to the 21.5% found in Perak and the 15.3% in Penang, it can be seen that facilities in these three areas account for more than 85% of all Malaysian foundries.

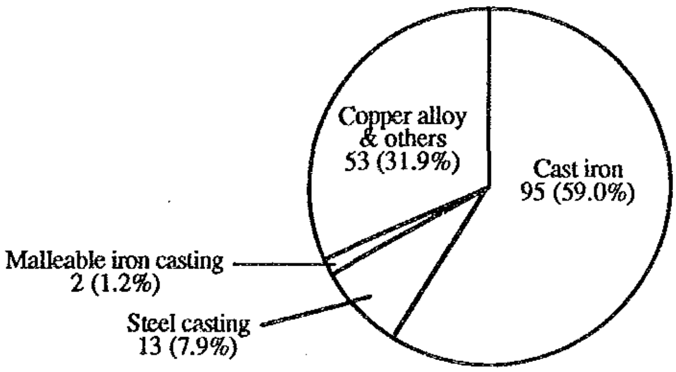
Fig. III.1-1 Distribution of Foundries by Region



2) Distribution of foundries by material

95 of the facilities were cast iron foundries, and 13 cast steel foundries, these two groups accounting for 66% of all plants. A breakdown of production by material is provided in the following section (2) Production scale.

Fig. III.1-2 Distribution of Foundries by Material



(2) Production scale

Malaysian production of castings in 1988 was estimated at 55,884 tons. The three most common materials were cast iron, steel casting, and malleable iron casting, their respective shares being 59.8%, 24.7%, and 7.1%.

Production value for the same year totaled an estimated M$187.7 million. The breakdown by material is as shown in the Table below.

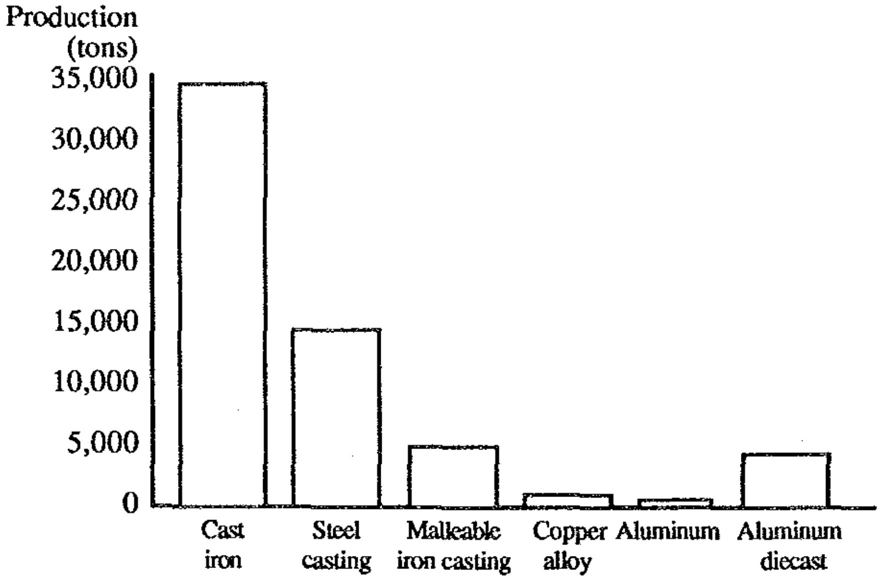
Table III.1-1 Estimated Production of Castings in Malaysia (1988)

Material	No. of foundries: No. interviewed or responding to questionnaire	No. of foundries: Estimated total no.*	Production (tons): No. interviewed or responding to questionnaire	Production (tons): Estimated total production	Unit price (M$/kg)	Sales (M$1,000)
Cast iron	75 (53.6)	95 (59.0)	26,385 (58.9)	33,421 (59.8)	2.3	76,868
Steel casting	12 (8.6)	13 (7.9)	9,902 (22.1)	13,802 (24.7)	3.6	49,687
Malleable iron casting	2 (1.4)	2 (1.2)	3,960 (8.9)	3,960 (7.1)	4.3	17,028
Copper alloy	21 ⎤	8 ⎤	1,029 (2.3)	1,070 (1.9)	12.2	13,054
Aluminum	14 ⎬ 51	20 ⎬ 53	432 (1.0)	449 (0.8)	9.6	4,310
Aluminum diecast	16 ⎦ (36.4)	25 ⎦ (31.9)	3,060 (6.8)	3,182 (5.7)	8.4	26,729
Total	140 (100.0)	163 (100.0)	44,768 (100.0)	55,884 (100.0)	—	187,676

Source: JICA Study Team estimates
Figures in parentheses indicate percentage share of total.
*Estimates for the total number of foundries were provided by industry sources.

(Method of calculation)
Cast iron: 26,385 ton/year x 95/75 = 33,421
Steel casting: 3,900 tons/year (annual production at one large factory) added to the survey statistics
Copper, aluminum, diecast: 4% added to the survey statistics in each of these categories

Fig. III.1-3 Malaysian Production of Castings by Material (1988)



III-1-3. Export-import and Local Sales

(1) Export and Import

According to trade statistics, Malaysia exported M$1.27 million of casting products in 1987 while importing M$2.83 million of the same.

It is considered that there is a high ratio of indirect trade, indicating cases in which castings are used as components in automobiles or machinery. Taking the indirect trade into consideration, indirect imports appear to outpace direct import considerably in Malaysia. Because of the high transportation costs required for these products, however, direct export ratios of casting products are usually low in any country in comparison with those of other products.

Table III.1-2 Exports of Casting Products

(Unit: M$)

		1985	1986	1987
679,411.00	Manhole covers, gratings & frames thereof cast iron	95,270 (93,605)	214,332 (211,824)	307,146 (290,451)
679,419.00	Other iron castings in the rough state	491,542 (482,463)	515,913 (471,957)	427,880 (316,684)
679,420.00	Manhole covers, gratings & frames thereof cast steel	20,612 (20,612)	—	20,136 (11,413)
679,429.00	Other steel casting in the rough state	2,045,050 (1,744,012)	770,021 (671,544)	515,383 (339,703)
	Total	2,652,480	1,500,266	1,270,725

Source: Malaysia External Trade Statistics
( ): Export to Singapore
Imports of castings for the three years totaled M$2,549,194, M$2,921,748, and M$2,825,775, respectively.

The following report on export was drawn up based on the results of the questionnaire survey.

1) Export

28 firms responded to the question concerning export ratios. These 28 firms account for 27.2% of all the firms responding to the questionnaire, and roughly half indicated export ratios of 10-29%.

Five firms each reported export ratios in the ranges 1-9% and 30-39%. Three companies had ratios exceeding 50%, with products including household goods and gas stoves. One die casting foundry interviewed reported that fully 80% of all its production was destined for overseas markets. Some of the firms with high export ratios, however, pointed out that the fierce competition in foreign markets made it dangerous to depend too heavily on exports.

2) Products for export

Products for export indicated by the 28 firms above are listed below.

Rubber processing machinery
Gas stoves, gas stove burner heads
Gas heating systems
Sterilizers
Firefighting equipment
Gear box water pumps
Gravel pump covers
Piano frames
Mine pumps
Hard pumps
LPG burners
Pipe fittings
Water gravel pumps
Parts for mining equipment
Ductile iron pipes and fittings
Gray cast iron pipe fittings
Worm screws for palm oil

3) Export markets

The following responses were obtained concerning export destinations (numbers indicate the number of companies).

Singapore	14
Indonesia	8
Thailand	6
U.S., Europe, Australia, Japan	2
Kuwait, Africa, Hong Kong, Netherlands, Papua New Guinea	1

4) Export initiative

A great deal of interest is being shown in exports. 50 firms, including 18 firms which had visited foreign buyers, reported that they were engaged in some type of export promotion activity.

However, there remains a shortage of information concerning overseas markets, and many firms indicated their dissatisfaction with the information currently available from government bodies and industry associations.

(2) Local Sales

Most of the foundries did business with customers in the traditional industries of tin, palm oil, rubber, and timber, and most buyers were private companies. In a questionnaire survey, 99 out of 123 firms (80.5%) indicated that most of their business was done with private-sector firms, while 22 (17.9%) did more business with the public sector. Two firms did business with others. In business with the traditional industries described above, direct sale is the most common type of transaction regardless of whether the customer is publicly or privately-owned, but vendor markets exist for motorcycle parts, daily goods, hardware, and some mechanical components. Concerning the sales organizations at these companies, 40 of the 73 responding firms (71.3%) answered that they employed one person as sales staff; 10 (17.9%), two people; 3:, three people and 3 four or five people.

III-1-4. Recent Industry Trends

The IMP (Industrial Master Plan) marked the first time that the casting industry had been designated as one of the key industries by the Malaysian government. Cast metal products were classified under the "Machinery & Engineering" heading, one of the 12 in the IMP, a task force was established to conduct surveys of cast metal products, and working committees and subcommittees were created to work with the private sector on studying the establishment of the Foundry and Engineering Park described below. There have been other projects as well, including HICOM, which will manufacture components for motorcycles and automobiles, and a machinery manufacture and training project currently under negotiation with India. Although details on these projects have yet to be announced, they would seem to represent new sources of demand for cast metal goods and hence are being watched with considerable interest.

1) Foundry and Engineering Park

The development of Malaysia's tin industry brought about a rapid rise in the number of small-scale plants located on TOL (Temporary Occupied Land) in the Klang and Ipoh regions. Small land plots and a high concentration of foundries in a limited area, however, generated fears of pollution, and the government ultimately forced these operations to move in a project to promote "green cities." Before the project in Selangor, Ipoh secured 150 acres of land in Pengkalan, of which 115 acres was allotted to firms in the foundry and engineering sector. In addition to a Common Facility Centre offering a showroom, laboratory, and an information center, this spacious Park serves to promote linkages between companies with common interests. Further cooperation between the private and public sectors will be needed to support the development of the industry.

MIDA gave the following concept of a foundry and engineering park in "*Proposal Paper for the Establishment of a Foundry and Engineering Park in Selangor and Perak* (September 1988)". The concept is considered to be capable of responding to the individual needs of the tenant firms.

Concept of a Foundry and Engineering Park

The proposed foundry and engineering park would accommodate foundry operators and others related to the foundry trade such as pattern makers, mould and die makers, foundry machinery and equipment suppliers and suppliers of foundry raw materials and additives. The set-up would also include the establishment of common facilities such as those for research and development, testing, heat treatment, etc. It is proposed that the following buildings, trades and amenities be accommodated in the foundry park:-

(a) Foundries with office stores, laboratories, etc. built to individual design on individual lots.

(b) Cheaper standardised units built for smaller size foundry/die casting operators.

(c) Offices with showrooms and stores and dealers in foundry machinery and equipment.

(d) Offices with stores for foundry/die casting material suppliers.

(e) Workshops with offices and stores for foundry pattern makers.

(f) Workshops with offices and stores for mould and die makers.

(g) Administrative office with store for the foundry park management company to deal with general administrative work.

(h) Multi purpose block with:-

    [1] Cast products display area
    [2] Library and information centre with advisory service
    [3] Lecture rooms for talks and short courses
    [4] Foundry technology testing facilities
    [5] CAD/CAM facilities
    [6] R&D facilities
    [7] Meeting rooms
    [8] Administration office
    [9] Canteen

(i) Fabrication and welding workshops

(j) Machine shops, assembly, repairs

(k) Workshops for heat-treatment, shot-blasting, chrome plating, etc.

(l) LLN sub-station

(m) Hawker centre

(n) Playing fields

(o) Community hall

The multi-purpose block is to be run and managed by a group comprising representatives in foundry industry. Buildings may be built by owner/operators themselves/or by a development company or financial institution for sale or rental to other operators.

It is essential that the foundry complex should have access to good roads, good drainage system, adequate public utilities, pollution control and waste disposal systems, fire fighting and security systems.

Source: MIDA "Proposal paper for the establishment of a foundry and engineering park in Selangor and Perak"

2) HICOM Engineering Sdn. Bhd.

HICOM Engineering Sdn. Bhd.owned entirely by HICOM is the manufacturer of cast metal parts for automobiles. The industry is very interested to find out when and how this firm, whose factory is currently under construction, will break into the precision casting market. [See Note (1)]

3) HICOM Diecastings Sdn. Bhd.

This company will begin production of motorcycle parts in September 1990. It also has plans to move into the heavy industry sector in the future. [See Note (2)]

4) Advanced Training Centre, Engineering Industries Complex

This project, currently under negotiation between the Ministry of Youth and Sports and HMT (International) Ltd. of India, aims at both the on-the-job training of workers and the production of machine tools and would be the first of its kind for Malaysia. [See Note (3)]

Notes:

(1) Commercial production is scheduled to begin in February 1991, with an expected payroll of 130 employees. Initially, production will centre around automotive components such as brake discs and drums, rear hubs, brake calipers, steering knuckles, exhaust manifolds, engine brackets, pulleys, water pumps, and flywheels, with plans to manufacture heavy equipment, compressors, and munitions in the future.

(2) Commercial production is scheduled to begin in October 1990 with a staff of 65. Main production items will include motorcycle engine parts (crankcases, crankcase covers, etc.) and alternators and housings for automobiles.

(3) Still in the process of negotiation at the time of the local survey, this project is slated for commencement on May 10, 1990 as the Advanced Training Centre (ATC). The training programmes, designed to improve the standards of production technology for metal machining, will target technicians, craftsmen, and machine operators. A single training course will be capable of accommodating 204 trainees for the training period of 1-2 years. Short courses lasting 3-12 weeks will also be available.

III-1-5. Industry Promotion Policies

(1) Industrial Master Plan

The IMP has designated machinery and engineering (subdivided into the foundry, mould and die, machinery, and fabrication sectors) as a key industry and provides direction for the industry and potential investors. Directions for the industry are explained in Volume II, part 10, MACHINERY AND ENGINEERING."

(2) Product strategy

The IMP has made two proposals concerning the priority and scheduling of products for domestic production in its product strategy for the machinery and engineering industry. One gives 57 products as "examples of products classified according to various levels of technology requirements," ranking these in the order A, B, C from the lowest technical level up. The IMP has as one of its goal the upgrading of production technology levels from A to B and finally to C by the year 1995.

The other proposal classifies machinery and machinery components and specifies a time schedule for the crossover to domestic production which is divided into three phases: 1986-1990, 1991-1995, and post-1995. These products are listed in the Appendix "Products to be considered for local production."

(3) Incentive measures (Pioneer Status)

Casting has been designated by the Minister of Trade and Industry as an industry for promotion, and as such it is eligible to apply for Pioneer Status.

III-1-6. Supporting Service Facilities

With the objective of contributing to the development of Malaysian industry, Malaysian government bodies have been the focus of efforts to provide education and training as well as a variety of services such as technical guidance and testing and inspection. The following section will discuss the activities being undertaken by major related bodies with a focus on foundry industry.

(1) MARA Vocational Training Schools

The MARA vocational training schools form one of MARA agencies under the authority of the Ministry of National and Rural Development. They have been engaged in vocational training since 1966 with the objective of producing Bumiputra technicians. There are nine schools at present, with plans in the Fifth MP for an additional three. Vocational training is currently being conducted for 39 trades, of which three are related to electronics technology: electronic instrumentation, industrial electronics, and radio and television repair. The training centers around repair and maintenance techniques.

Applicants are required to have completed secondary schooling (i.e., 11 years of schooling and an M.C.E.). Classes are held 36 hours a week, with one semester consisting of 17 to 20 per semester and a total of 120. Annual numbers of intakes/graduates of the casting course are as follows.

1977	1978	1979	1980	1981	1982	1983
14/1	14/3	23/12	28/29	21/19	81/84	78/69

1984	1985	1986	1987	1988	1989	1990	Total
22/23	21/41	20/17	21/13	33/22	28/5	0/28	404/366

Source: IKM

(2) Centre for Instructor and Advanced Skill Training (CIAST)

The Centre for Instructor and Advanced Skill Training (CIAST) was founded in Shah Alam, Selangor in 1984 with Japanese assistance and technical cooperation. CIAST was established to train and re-train technical instructors at public training facilities and plant managers at private corporations, and it is considered the summit of public training facilities in Malaysia. More than 2,000 individuals have received training at CIAST since its establishment, and in March 1988 a regional training program targeting rural areas was begun. CIAST also functions as a regional training center for ASEAN, and in 1988 a regional training program was held for ASEAN member nations.

CIAST training courses can be broadly divided into those offering (1) instructor and manager training and (2) advanced skills training. Since attendance requires the NITTCB Intermediate Certification, most of the attendants are instructors at vocational training institutes or plant managers at private companies. As a result, the courses are divided into two- to four-week modules to allow free selection. Trainees receive a "module certificate" upon completion of a module, while a "proficiency certificate" is presented to those who complete all of the modules in a given course.

The instructor training course consists of a six-month course in methods of instruction and nine one- to two-week modules in basic training techniques, skills analysis, audiovisual teaching materials, etc. The manager training course consists of seven one- to two-week modules covering quality control, safety management, and production planning and management.

Course names, module numbers, and course periods for the casting course are shown below.

Casting course: Gating and Risering System

Module number. H.2 1

09/01/87	09/18/87
01/09/89	01/27/89
07/17/89	07/24/89

Casting course: Gating and Risering System

Module number. H2.1.84

08/19/85	09/06/85
10/06/86	10/24/86

Casting course: CAD Gating and Risering System

Module number. H2.2

04/17/89   04/21/89

Casting course: Steel Casting

Module number. H2.2.84

09/02/86   09/23/86

06/87/87   06/26/87

Casting course: Casting

Module number. H2.3

01/18/88   02/05/88

06/27/88   07/15/88

Casting course: Non-iron Casting

Module number. H2.3.84

07/14/86   08/01/86

Casting course: Cupola Melting

Module number. H2.4

05/15/89   05/19/89

07/03/89   07/17/89

Casting course: Analysis of Casting Defects in Die Casting

Module number. H2.5

12/07/87   12/11/87

10/31/88   11/04/88

Source: CIAST

(3) Foundry Technology Unit (FTU)

[One of the units of Metal Industry Development Centre (MIDEC) in Standards and Industrial Research Institute of Malaysia (SIRIM)]

FTU started out as one of the units of MIDEC but has grown to become Malaysia's sole facility engaged in casting technology R&D. Today it boasts facilities and personnel on a par with those of MIDEC at the time of its establishment.

FTU was founded via the following process. In July 1986 the Malaysian government requested the cooperation of Japan, which then dispatched a fact-finding mission in September-October 1987 and in the following April-May conducted a survey concerning the possibility of cooperation and types of assistance. In October 1988 a team was dispatched to discuss concrete details of the project, and on October 12 the Record of Discussions was signed by both sides, with the cooperative project beginning on this day.

This section will first discuss FTU activities and then provide a summary of Japanese cooperation.

1) FTU activities

[1] Location and size

Standards and Industrial Research Institute of Malaysia
P.O. Box 35, 40700 Shah Alam, Selangor Darul Ehsan
Location (Block N, SIRIM headquarters)
Office 145.3 m^2 Conference room, computer room, etc. 102.3 m^2
Experimental plant 10,549 m^2 137.5 m^2

[2] FTU role and activities

At present, SIRIM is trying to shed its traditional emphasis on testing operations and become an R&D organization capable of leading efforts to achieve advanced industrialization under the motto, "A Friend and Partner of Industry." It is hoped that the role of the FTU will change from one of simply supporting related industries to one involving leadership through R&D.

R&D and services constitute the two major aspects of FTU activities. SIRIM also has a standards division responsible for the handling of industrial standards, and offering assistance to this division is one of the main services provided by FTU.

Following is a list of the activities currently being pursued by FTU.

(a) R&D

1) To carry out R&D on advanced utilization technologies for locally-available raw materials with the objectives of improving local casting technology and product quality and reducing manufacturing costs.

2) To promote product diversification and thereby expand the market for local industry. Also, to contribute to the localization of production of items which are currently imported.

3) To pursue manufacturing technologies for large-scale and high-quality castings.

(b) Services

i) To offer technical consultation and guidance in order to improve the quality of local cast metal products.

ii) To achieve the dissemination of casting technologies through the sponsoring of seminars, workshops, and training programs.

iii) To assist the standards division of SIRIM in drawing up casting-related industrial standards.

2) Technical cooperation

[1] Project name

Japanese Technical Cooperation for the Project on Foundry Technology Unit in the Standards and Industrial Research Institute of Malaysia

[2] Project duration

5 years (October 12, 1988 - October 11, 1993)

[3] Objectives

This project has as its objective the training of personnel capable of transferring technology to local companies (and hence the technological development of the Malaysian casting industry) through technical guidance, testing and inspection services, information services, and training programs in the field of casting technology.

In order to achieve these goals, the Japanese side will, throughout the duration of the project, provide technical guidance and advice in the following fields for the training of its Malaysian counterparts.

(1) Model fabrication

(2) Melting

(3) Mould fabrication

(4) Quality control

(5) Testing and inspection

(6) Finishing

(7) Product development

[4] Dispatch of experts

Long-term (4) (chief advisor, coordinator, melting expert, mold-making expert)

Short-term (as needed) (15 had been dispatched as of the end of May 1990)

[5] Acceptance of trainees

Nine had been accepted as of the end of May 1990.

[6] Provision of equipment and materials

The main equipment and materials to be provided are as follows.

(a) Model fabrication		
Set of materials for wooden mould fabrication		1
(b) Melting		
High-frequency induction furnace; 500, 100, and 80-kg crucibles		1 of each
(c) Models		
Joint squeeze moulding machine	650 x 575mm	2
Core blowing machine	310(W) x 400(L) x 340(H) mm	1
Shell core machine	300(W) x (70/70) x 300(H) mm	1
Sand processing system for CO2 and furan moulds		1
Sand processing system for green sand moulds		1
Sand drying system		1
Sand testing system		1
(d) Testing and inspection		
Fluorescent X-ray spectroscopy system		1
CS analysis system		1
(e) Finishing		
Shot blasting machine		1
Double-headed grinder		1
(f) Other		
Personal computers		6
Video equipment		1
Microbus		1
Land Cruiser		1
Casting-related reference materials		

Source: FTU

III-2. Present Status of Production

III-2-1. Production of Castings by Demand Industry and Material

Table III.2-1 shows a breakdown of production by demand industry and material as calculated from the questionnaire results. As is clear from the Table, demand for cast iron and steel casting is centered in the rubber, tin, and palm oil industries; for copper alloy casting, in the rubber, tin, and shipbuilding industries; for die casting aluminum casting, in the rubber, tin, and construction industries; for aluminum, in the construction and motorcycle industries; and for malleable iron casting, in construction.

Table III.2-1 Breakdown of Production of Castings by Demand Industry and Material (1988)

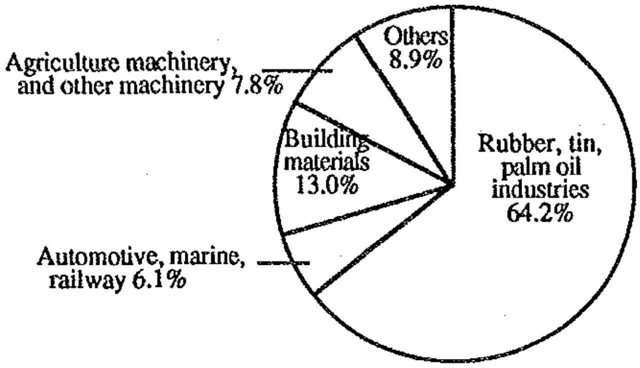
(Unit: %)

Demand industry	Cast iron	Malleable iron casting	Steel casting	Copper alloy casting	Alu-minum	Die casting
1. Rubber	13.0	—	9.5	24.0	20.0	0
2. Tin	24.3	—	33.3	20.0	30.0	0
3. Palm oil	13.9	—	28.6	12.0	0	0
4. Timber	13.0	—	4.8	0	0	0
5. Building material	13.0	100	4.8	8.0	20.0	19.0
6. Automotive	2.6	—	0	4.0	0	4.8
7. Motorcycle	0.9	—	4.8	4.0	0	14.3
8. Railway	0.9	—	0	0	0	0
9. Agriculture machinery	2.6	—	0	0	10.0	0
10. Marine	1.7	—	0	20.0	0	9.5
11. Electrical equipment	0	—	0	0	20.0	38.1
12. Other machinery	5.2	—	9.5	4.0	0	0
13. Others	8.9	—	4.7	4.0	0	14.3
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Questionnaires

In other words, the Malaysian casting industry is still highly dependent on traditional industries. As for copper alloy casting, aluminum casting or die casting, however, they have recently found application in the marine, electrical and motorcycle industries.

Fig. III. 2-1 Production of Cast Iron by Demand Industry



III-2-2. Production by Material

Table III.2-2 shows a breakdown of Malaysian production by material. As is clear from the Table, the scale of production at most plants in the Malaysian casting industry, with the sole exception of malleable cast iron, is very small.

Table III. 2-2 Number of Foundries by Material

Material	Production scale (tons/year)							
	100>	300>	500>	1,000>	2,000>	3,000>	3,000<	Total
Cast iron	11	27	20	11	3	1	0	73
Malleable iron casting	0	0	0	0	1	1	0	2
Steel casting	3	1	1	3	3	0	1	12
Copper alloy	16	5	0	0	0	0	0	21
Aluminum	14	0	0	0	0	0	0	14
Die cast	7	4	3	2	0	0	0	16

Source: Questionnaires

In the case of cast iron, 14.7% of all plants (11) had an annual production capacity of less than 100 tons (approx. 8.5 tons/month); 36.0% (27), annual capacity of 100-300 tons; and 27.4% (20), annual capacity of 300-500 tons. These plants accounted for 77.3% of the total (58), thus indicating the small-scale nature of cast iron production in Malaysia.

The only two plants engaged in the production of malleable iron casting were large-scale facilities, one with annual production of 1,000-2,000 tons and one with capacity of 2,000-3,000 tons.

Only five factories out of 12 which are engaged in the production of steel casting showed annual production of less than 500 tons per year (approx. 42 tons/month), indicating the slightly larger scale of steel casting operations.

In the field of non-ferrous metals, 16 out of 21 coper alloy foundries, or 76.2% of the total, were small facilities with annual production of less than 100 tons. All of the factories engaged in the production of aluminum casting also fell into this category. Seven out of the 16 die casting factories, or 43.8%, reported annual production of less than 100 tons, but two of the facilities also fell into the 500-1,000 ton category.

III-2-3. Manufacturing Methods

(1) Furnaces

Table III.2-3 shows a breakdown of the types of furnaces used in the Malaysian casting industry by material.

Table III.2-3 Number of Foundries by Material and Furnace Type

Material	Furnace type				
	Cupola	Low-frequency induction furnace	High-frequency induction furnace	Arc furnace	Crucible furnace
Cast iron	69	2	4	0	0
Malleable iron casting	1	1	0	0	0
Steel casting	0	2	9	1	0
Copper alloy casting	0	0	0	0	21
Aluminum casting	0	0	0	0	14
Die casting	0	0	0	0	16

Source: Questionnaires and factory visits

In the case of cast iron, virtually all of the facilities used cupola, with just six found to be using induction furnaces. Three of these factories were engaged primarily in the production of steel casting and were making ductile cast iron. The other three were relatively large factories engaged solely in the production of cast iron products such as automobile components, valves, piano frames, centrifugal cast iron pipes, liners and valves for diesel engines, and metal moulds for glassmaking.

Only two Malaysian firms are involved in the manufacture of malleable iron casting. One uses a cupola furnace, while the other depends on a low-frequency induction furnace. In terms of the strength of the cast iron which can be obtained, the latter method is somewhat superior because of the lower resulting carbon content (2.6-2.8% vs. approx. 3%).

In the industrialized nations arc furnaces are generally used for melting during the production of steel casting because of their low power consumption and their tolerance for low-grade scrap metal. In Malaysia, however, high-frequency induction furnaces are the most commonly used. Given the views on the cost savings of electrical power and the scarcity of steel scrap in this country, however, arc furnaces would be more appropriate. As is seen in Table III.2-3, only one Malaysian factory uses an arc furnace. Due to the large (8-ton) capacity of the model in use, moreover, it is used primarily for the production of steel bars rather than steel casting, for which a high-frequency induction furnace is used. Two companies use low-frequency induction furnaces, which are seldom used in the industrialized nations because of long melting times and the difficulty of bringing up the furnace temperature. Reasons why arc furnaces are not used at Malaysian steel casting foundries include a lack of the technical expertise required to operate this type of furnace combined with the ease of operation offered by high-frequency induction models.

In Malaysia, crucible furnaces are used during the casting of non-ferrous metals such as copper alloy and aluminum as well as in die casting. A similar situation can be found in the industrialized nations. Petroleum, gas, and coke are used as heat sources.

Regardless of the type of metal, the following characteristics are required of a melting furnace:

(1) No oxidation of or gas absorption by the molten metal

(2) Ability to reach the desired melting temperature

(3) Ability to provide a molten metal with the desired physical properties

(4) Ability to provide a molten metal with the desired chemical composition

In order for a melting furnace to provide the desired properties, operators must have a thorough knowledge of the primary and subsidiary materials used in melting, of the physical structure of furnace refractories, and of the operation of the furnace. At the factories visited during the survey, the ample room for improvement was recognized in this area.

In the case of the primary material, for example, an excess of rust or oil or the introduction of different types of metal were found to lead to casting defects. It would be necessary to remove any rust and oil using a tumbler or shot blasting machine and eliminate any foreign substances.

(2) Moulding sand and sand reclamation

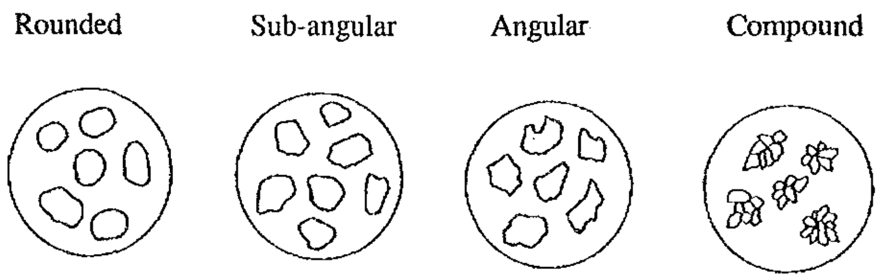
1) Moulding sand

The leading types of moulding sand used in Malaysian casting factories are as follows: high-quality Johor sand, named for the Johor district from which it is taken; the tin mining sand produced in the tin mines of Kuala Lumpur and the Ipoh district; river sand; and soil sand. Johor sand has a silica content exceeding 98% and a round grain shape, but since grains are often smaller than 70 mesh the sand must be screened to 35-60 mesh. This naturally increases costs. As a result, Johor sand is often used in shell moulds but is generally held to be too fine for use in general casting applications.

Tin mining sand has a sub-angular grain shape that results in poor fluidity during moulding and often leads to moulding defects. It is therefore suggested that a conical machine be used to round out the grains. In Japan, this technique is used by sand suppliers in order to provide their customers with rounded sand.

Of the varieties of moulding sand recognized by the American Foundrymen Society (AFS) and shown in Fig. III.2-2, rounded sand is held to be the most desirable. Photograph 1 shows the grain shape of tin mining sand taken from the Selangor Rawang district, and Table III.2-4 shows grain size distributions for three types of sand obtained from the same location. For reference, Japan Industrial Standards (JIS) for moulding sand are shown together with examples of Japanese silica sand.

Fig. III.2-2 Grain Size Distribution of AFS



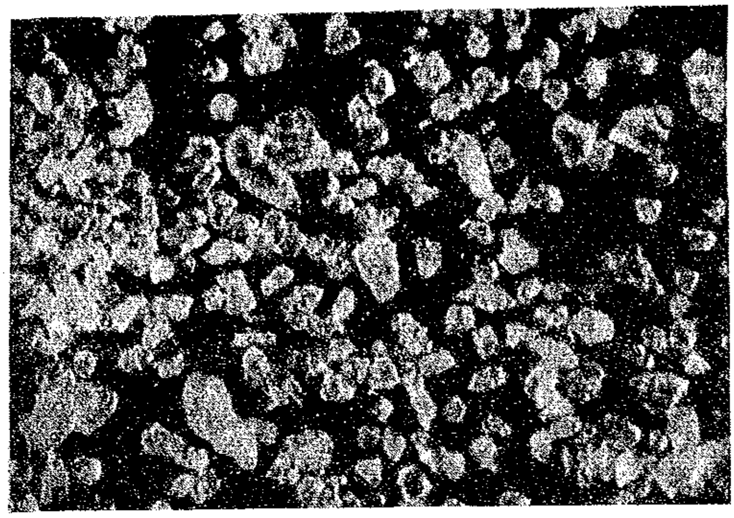


Photo
(Sand grain shape in tin mining in Rawang region, Selangor state)

Fig. III. 2-3 Degree of Purity of Silica Sand for Die Casting

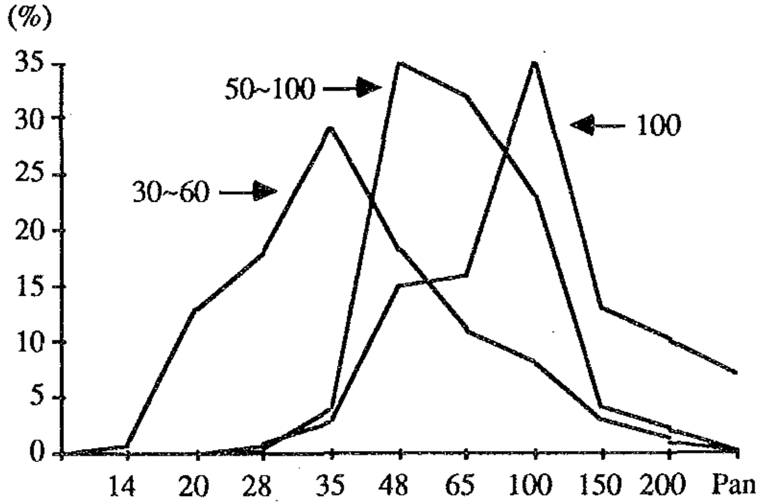


Table III.2-4 Grain Size Distribution of Malaysian Silica Sand

Type	14	20	28	35	48	65	100	150	200	270	Pan	Total	Clay content
30~60	0.1	0.8	12.3	18.3	28.4	18.3	11.1	7.4	1.8	0.6	0.2	99.3	0.7
50~100	tr	tr	0.2	0.5	4.1	35.3	31.3	21.4	4.7	1.7	0.2	99.4	0.6
100	0	tr	0.2	0.8	2.8	15.0	16.2	34.8	13.2	9.7	6.1	98.8	1.2

Note: Sand was taken from the Rawang region of Malaysia and tested by Saitama Casting Equipment Industries.

Table III.2-5 Purity Grades of Molding Silica Sand (JIS G5601)

(Unit: %)

Purity		Impurities		
Grade	SiO_2	Fe_2O_3	Al_2O_3	CaO+MgO
1st	More than 98.1	Less than 0.5	Less than 1.0	Less than 1.0
2nd	96-98	Less than 1.0	Less than 2.0	Less than 1.5
3rd	93-96	Less than 1.5	Less than 4.5	Less than 2.0
4th	90-93	Less than 2.0	Less than 6.0	Less than 2.5
5th	85-90	Less than 3.0	Less than 8.0	Less than 3.0
6th	70-85	Less than 5.0	Less than 15.0	Less than 5.0

JIS of foundry sands
Moulding silica sand JIS G 5601 (1974)

As can be seen in Table III.2-4, clay content is less than 2% and Table III.2-5 shows that purity is divided into six grades, Grade 1 having a SiO_2 content exceeding 98%. This is used primarily for steel casting. Grade 4 and above are used for cast iron, while Grades 5 and 6 are used for casting of non-ferrous metals.

Table III.2-6 shows JIS grain size numbers for silica sand. As can be seen from the Table, since the peak sand wt% for the 10-35 mesh sand is at least 40% and that of the >48 mesh sand at least 30%, the peak sand wt% of any sieve and its two neighbors will always be at least 70%.

Table III.2-6 Grain Size of Silica Sand (JIS)

(Unit: %)

Size No.	Nominal Dimension of Sieve μ			Peak	Wt% of peak	Wt% of 3 sieves
10 Mesh	2,380 (8)	1,680 (10)	1,190 (14)	1,680 (10)		
14 Mesh	1,680 (10)	1,190 (14)	840 (20)	1,190 (14)		
20 Mesh	1,190 (14)	840 (20)	590 (28)	840 (20)	>40	
28 Mesh	840 (20)	590 (28)	420 (35)	590 (28)		
35 Mesh	590 (28)	420 (35)	297 (48)	420 (35)		>70
48 Mesh	420 (35)	297 (48)	210 (65)	297 (48)		
65 Mesh	297 (48)	210 (65)	149 (100)	210 (65)		
100 Mesh	210 (65)	149 (100)	105 (150)	149 (100)	>30	
150 Mesh	149 (100)	105 (150)	74 (200)	105 (150)		
200 Mesh	105 (150)	74 (200)	53 (270)	74 (200)		

Note: 1. ( ) means mesh. Wt% of 3 sieves if peak size and neighbors.
2. JIS 5601

This has a favorable impact on the permeability, mouldability, and strength of the moulding sand. The grain size numbers shown in the Table are actually the mesh of the peak sand.

Table III.2-7 Typical Japanese Moulding Sand

	20	28	35	48	65	100	150	200	270	Pan	AFS (Finess No)
A sand	1.6	16.2	38.2	28.1	12.0	3.0	0.6	0.1	0.1	0.1	35.4
B sand	tr	1.0	4.1	16.2	34.0	31.8	12.3	0.2	0.1	tr	53.9
C sand	0.2	0.4	3.0	13.4	39.6	17.8	8.6	1.6	0.8	1.7	51.3

Based on the Tables and Figures shown above, it was judged that the silica moulding sand used in Malaysia has too loose a grain size distribution and requires improvement.

2) Sand reclamation

When moulding sand is used repeatedly, the concentration of mixed and added substances (clay, coal dust, starch, etc.) increases, and the silica sand itself can be crushed by the tremendous heat load, thereby impairing its properties as a moulding sand. The sand must therefore be monitored to keep additive content at a constant level.

Fig. III.2-4 Grain Size Distribution of Japanese Silica Sand

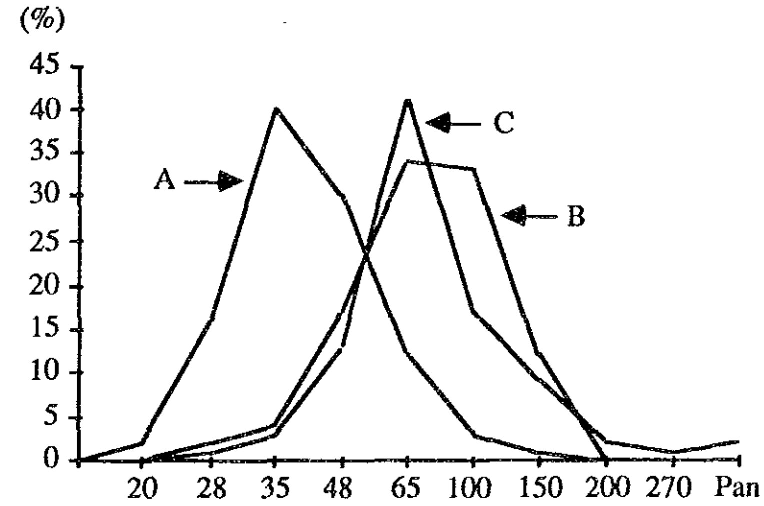


Table III.2-8 shows data obtained from the questionnaires concerning the reclamation of moulding sand at Malaysian cast iron foundries. It can be seen from the Table that small-scale factories are not very active in sand reclamation. This results in more casting defects due to deterioration of the moulding sand.

Table III.2-8 Reclamation of Moulding Sand at Malaysian Cast Iron Foundries

Production /year (tons)	No. of factories	No. of factories engaged in reclamation
<100	11	0
<300	27	6
<500	20	3
<1,000	11	2
<2,000	3 (1)	3 (1)
<3,000	1 (1)	0 (1)
>3,000	0	0
Total	73 (2)	14 (2)

Source: Questionnaires
Figures in parentheses indicate malleable cast iron foundries.

Table III.2-9 shows moulding sand reclamation at steel casting foundries. The facing sand is generally new sand, while reclaimed sand is used the back sand. It was noted in Table III.2-11 that most steel casting foundries use CO_2 moulds. Use of reclaimed sand for the back sand in these moulds would be effective.

Table III.2-9 Reclamation of Moulding Sand at Malaysian Steel Casting Foundries

Production /year (tons)	No. of factories	No. of factories engaged in reclamation
<100	3	0
<300	1	1
<500	1	0
<1,000	3	0
<2,000	3	1
<3,000	0	0
>3,000	1	1
Total	12	3

Source: Questionnaires

Three of the steel casting factories surveyed were engaged in the reclamation of moulding sand. Of these, those with annual production capacities in the range 1,000-2,000 tons and >3,000 tons use pepset moulds, and all of the sand used in these moulds is reclaimed.

In the case of non-ferrous alloys, green sand moulds are most common. It is suggested that the sand used in these moulds be reclaimed and occasionally mixed with new sand to prevent aging.

(3) Moulding Process

1) Types of moulds

a) Cast iron

Table III.2-10 shows that green sand moulds, CO_2 moulds, and cement moulds are most commonly used in the production of cast iron. Specifically, 24 out of 75 factories (32.0%) used green sand moulds, while 23 (30.7%) used CO_2 moulds and 46 (61.3%) cement moulds.

Table III.2-10 Types of Moulds Used in Malaysian Cast Iron Foundries

Production /year (tons)	No. of factories	Green sand moulds	CO_2 moulds	Cement moulds	Shell moulds (core)	Pepset moulds
<100	11	5	6	7	3	0
<300	27	7	7	22	2	0
<500	20	5	6	8	3	1
<1,000	11	3	3	9	2	0
<2,000	3 (1)	2 (1)	0	1	3	1
<3,000	1 (1)	(1)	1	0	0	0
>3,000	0	0	0	0	0	0
Total	73 (2)	22 (2)	23	47	13	2

Source: Questionnaires and factory visits
Figures in parentheses indicate malleable cast iron plants

Semi-synthetic skin dry moulds are generally used for products used in local tin mines; green sand moulds, for burners and valves in autmobiles, agricultural equipment, and kitchen appliances as well as piano frames and other mass-production items; and cement sand moulds, for the production of low-volume items such as mechanical components. Organic chemical resin binder ("no-bake") moulds were used at two factories. Shell moulds were used for the cores of small mass-produced items.

In Japan and other industrialized nations as well as NIEs such as Korea and Taiwan, CO_2 moulds are used only for cores, while cement sand moulds have been completely replaced by the organic no-bake moulds. Use of this type of mould is expected to increase in Malaysia as well in the future.

b) Steel casting

Table III.2-11 shows the types of moulds used at steel casting factories in Malaysia. As can be seen from the Table, CO_2 moulds are used by virtually all of the facilities. Green sand moulds and cement moulds were both used by three relatively small plants, while larger firms used pepset moulds (the organic no-bake variety described above).

In the industrialized nations, CO_2 and pepset moulds are the most commonly used for the production of cast steel. The former are used especially as alloy and cast steel moulds, while the latter are commonly used in the molding of carbon steel.

Table III.2-11 Types of Moulds Used in Malaysian Steel Casting Foundries

Production /year (tons)	No. of factories	Green sand moulds	CO_2 moulds	Cement moulds	Shell moulds (core)	Pepset moulds
<100	3	1	3	1	1	0
<300	1	1	2	1	0	0
<500	1	0	1	1	0	0
<1,000	3	1	2	0	0	0
<2,000	3	0	1 (1)	0	0	1
<3,000	0	0	0	0	0	0
>3,000	1	0	1	0	1	1
Total	12	3	10 (1)	3	2	2

Source: Questionnaires and factory visits
Figures in parentheses indicate the number of ester moulds and CO_2 cast moulds

c) Non-ferrous casting

Table III.2-12 shows the types of moulds used at copper alloy foundries in Malaysia. As can be seen from the Table, all of the 21 plants surveyed used green sand moulds, while three used CO_2 moulds and three cement moulds as well. The CO_2 moulds are used mainly for cores, while the cement moulds are used for the casting of propellors.

As is seen from the Table, copper alloy foundries are generally small in scale, with annual production at 18 of the factories totaling 419 tons, resulting in an average annual capacity of 23.3 tons per factory (roughly 2 tons/month). Production at the remaining three plants totaled 610 tons/year, averaging out to 203 tons/year (equivalent to 16.9 tons/month) at each factory.

Table III.2-12 Types of Moulds Used in Malaysian Copper Alloy Foundries

Production /year (tons)	No. of factories	Green sand moulds	CO_2 moulds	Cement moulds	Shell moulds (core)	Pepset moulds
<100	18	18	3	3	0	0
<300	3	3	3	3	0	0
<500	0	0	0	0	0	0
<1,000	0	0	0	0	0	0
<2,000	0	0	0	0	0	0
<3,000	0	0	0	0	0	0
>3,000	0	0	0	0	0	0
Total	21	2	6	6	0	0

Source: Questionnaires and factory visits

Table III.2-13 shows the types of moulds used at aluminum foundries in Malaysia. It can be seen from the Table that the 14 aluminum foundries in Malaysia have a combined annual production capacity of 432 tons, averaging out to approximately 30 tons/year or 2.5 tons/month for each factory and indicating the extremely small-scale nature of this sector. In addition, virtually all of these factories were part of copper alloy, die casting, or iron and steel-related foundries.

Virtually all of Malaysia's aluminum casting factories use green sand moulds. Three factories do use CO_2 moulds, but these are used for cores.

Table III.2-13 Types of Moulds Used in Malaysian Aluminum Casting Foundries

Production /year (tons)	No. of factories	Green sand moulds	CO_2 moulds	Cement moulds	Shell moulds (core)	Pepset moulds
<100	14	14	3	0	0	0
<300	0	0	0	0	0	0
<500	0	0	0	0	0	0
<1,000	0	0	0	0	0	0
<2,000	0	0	0	0	0	0
<3,000	0	0	0	0	0	0
>3,000	0	0	0	0	0	0
Total	14	14	3	0	0	0

Source: Questionnaires and factory visits

(3) Moulding methods

1) Cast iron

Table III.2-14 shows a breakdown of moulding methods used at Malaysian cast iron foundries. As can be seen from the Table, 60 out of the 75 factories, or 80%, used hand moulding, while the remaining 15 used machine moulding. Those foundries with annual production capacities exceeding 1,000 tons all used machine moulding. When classified by the use of moulding flasks, those facilities engaged in *flask moulding outnumbered those not using flasks.*

Table III.2-14 Moulding Methods at Malaysian Cast Iron Foundries

		Hand moulding	Machine moulding	Flask moulding	Flaskless moulding	Pit moulding
<100	11	9	2	5	3	2
<300	27	24	3	19	16	20
<500	20	18	2	5	1	6
<1,000	11	9	2	9	8	5
<2,000	3 (1)	0	3 (1)	4 (1)	0	0
<3,000	1 (1)	0	1 (1)	1	(1)	0
>3,000	0	0	0	0	0	0
Total	73 (2)	60	13 (2)	43 (1)	28 (1)	33

Source: Questionnaires and factory visits
Note: Figures in parentheses indicate malleable cast iron foundries

With the exception of the flaskless high-speed, high-pressure moulding system being used by one malleable cast iron foundry, all of the moulding machines used at Malaysian cast iron foundries were of the prototype jolt or jolt squeeze variety. Centrifugal casting machines were in use at two factories, one producing centrifugal cast iron pipe and the other small engine liners and related components. It was already pointed out in Table III.2-10 that the shell mould method is used for cores at 13 companies. According to the questionnaire results, these 13 factories possess a total of 37 shell machines, but virtually all of this equipment is concentrated at those facilities with annual production of at least 1,000 tons.

2) Steel casting

As shown in Table III.2-11, CO_2 moulds are the most commonly used for the moulding of steel casting. In Japan, no-bake moulding using organic chemical binders is the most often used method due to considerations of pollution and productivity. Only two Malaysian firms use no-bake moulds. Since the cement moulds and CO_2 moulds used at casting factories both require highly alkaline moulding sand with pH values in the range 10-11, they would pollute rivers and lakes, and this has been the reason for their gradual disappearance from Japanese foundries.

3) Non-ferrous metals

Tables III.2-12 and III.2-13 above show that green sand moulds are the most common varieties used in the moulding of non-ferrous metals in Malaysia. Large ship propellors and similar pieces are the exceptional products which are generally moulded using cement moulds or CO_2 moulds.

Low-refractoriness naturally-bonded sand, rather than the silica sand used in the casting of ferrous metals, is used as the moulding sand for the casting of non-ferrous alloys. Naturally-bonded sand is characterized by a fine grain (<100 mesh) and high clay content (20% - 25%), and is often called as mountain sand or soil sand
Because of the extremely small market, Malaysia's non-ferrous metal foundries have small production capacities and are usually either part of a larger corporation or engaged in the casting of copper alloy or aluminum or die casting on the side.

Die casting is the technique in which molten metal is mechanically forced into a metal die. *Table III.2-15 shows the number and size of die casting machines at* Malaysian die casting plants. The Table shows that most of the machines in use at these facilities have capacities of at least 100 tons.

Table III.2-15 Number of Die Casting Machines at Malaysian Die Casting Foundries

Production /year (tons)	No. of factories	30t	31~50t	51~100t	101~300t	301t~
<100	7	0	0	2	11	2
<300	4	0	0	1	2	5
<500	3	1	0	3	3	3
<1,000	2	0	0	0	4	5
<2,000	0	0	0	0	0	0
Total	16	1	0	6	20	15

Source: Questionnaires and factory visits

Table III.2-16 provides a summary of the moulding methods used for each material. The Table shows that 106 out of 122 foundries (86.9%) use hand moulding, while 25, or 20.5%, are engaged in machine moulding. The total exceeds 100% because some of the hand-moulding plants have also introduced machine moulding facilities. In the future, it will be necessary for Malaysian foundries to introduce automated high-speed, high-pressure moulding machines.

Table III.2-16 Breakdown of Moulding Methods at Malaysian Foundries by Material

Units: Number of factories/% of total

Material	No. of factories	Hand moulding	Machine moulding	Flask moulding	Flaskless moulding	Pit moulding
Cast iron	73 (2)/100	60/80.0	13 (2)/20.0	43/57.3	42 (2)/60.0	33/44.0
Steel casting	12/100	11/91.7	4/33.3	10/83.3	8/66.7	3/25.0
Copper alloy	21/100	21/100	3/14.3	13/61.9	8/38.1	12/100
Aluminum	14/100	14/100	4/28.6	14/100	10/71.4	10/71.4
Total	122/100	106/86.9	25/20.5	80/65.6	71/58.2	58/47.5

Source: Calculated based on questionnaires and factory visits

Flask moulding is somewhat more common than flaskless moulding. Although both of these methods have their respective advantages, flask moulding is able to offer slightly higher dimensional precision.

58 of the 122 foundries (47.5%) responding to the questionnaire answered that they used pit moulding. In contrast to the 44.0% of cast iron foundries and 25.0% of steel casting foundries using this technique, fully 100% of the copper alloy foundries and 71.4% of all aluminum foundries employed pit moulding.

Pit moulding is the technique in which a pit is dug in the floor to perform moulding. During the factory visits, this type of operation could be seen only at cast iron plants. The high percentages of this application indicated by the questionnaire results would be due to a confusion of this technique with floor moulding.

(4) Finishing Process

After the molten metal is poured into the mould, allowed to harden and removed from the mould, attached moulding sand is shaken out. Such unneccessary portion as the gate, sprue runner and bar are removed, and deburring is performed. The surface is then ready for finishing.

Cast metal pieces produced in Malaysia's larger foundries, as well as non-ferrous metal pieces, have a relatively good external appearance, but other varieties cannot be so favorably evaluated. This is due to a lack of understanding concerning moulding sand characteristics and insufficient knowledge and know-how concerning the use of this sand.

In the finishing process, all of the unnecessary portions are removed from the surface of the cast piece. The manufacturer has a responsibility to provide the customer with a product that adequately fulfills his needs.

Numerous machines are used in finishing cast metal: shake-out machines, used to shake out moulding sand; and turn blast machines, shot blast machines, grinders, and swing grinders, used to remove sand attached to the surface and for polishing.

As can be seen in Table III.2-17, five foundries (6.7% of the total) had a total of six shake-out machines; 13 factories (17.3%), a total of 21 turn blast machines; 10 factories (13.3%), a total of 25 shot blast machines; and 47 (62.7%), a total of 168 hand grinders and table grinders. No firms used swing grinders.

Table III.2-17 Finishing Facilities at Malaysian Cast Iron Foundries

Production /month (tons)	No. of factories	Shakeout machine	Turn blast	Shot blast	Swing grinder	Grinder
<100	11	0	1/1	1/1	0	13/6
<300	27	1/1	5/5	4/2	0	54/19
<500	20	1/1	4/4	4/2	0	26/11
<1,000	11	3/2	3/1	8/2	0	58/7
<2,000	3 (1)	1/(1)	3/(1)	3/2	0	12/3
<3,000	1 (1)	0	5/(1)	5/1	0	5/1
>3,000	0	0	0	0	0	0
Total	73 (2)	6/4 (1)	21/13	25/10	0	168/47

Source: Questionnaires and factory visits
Units: No. of machines/no. of factories

The number of firms conducting sand shake-out (5) was very low, even when the high-variety and low-volume nature of the products is taken into consideration.

Only 13 of the factories (17.3%) had turn blast machines. These machines are relatively small for finishing machines and are reasonably priced as well, and it is suggested that all plants producing smaller items have at least one on hand.

Ten factories (13.3%) had a total of 25 shot blast machines. That there were more of these than the smaller turn blast machines was probably due to the large size of the pieces handled by the casting industry.

Swing grinders are both powerful and efficient, but as yet they have seen no application in Malaysian cast iron foundries.

There are two types of grinders — table and portable — but they were lumped together for the current survey. 47 of the factories in the present survey (42.7%) possessed a total of 168 grinders. When viewed by annual production, these numbers can be broken down as follows. <100 tons: six factories, 13 units; 100-300 tons: 19 factories, 54 units; 300-500 tons: 11 factories, 26 units; 500-1,000 tons: 7 factories, 58 units; 1,000-2,000 tons: 3 factories, 12 units; and 2,000-3,000 tons: 1 factory, 5 units.

The average of more than eight units per factory for facilities in the 500-1,000 ton range is abnormally high, but this is due to two factories in the group which possessed 30 and 10 units, respectively, and is not characteristic of the group as a whole. In the 300-500 ton class, the average was 2.3 units per factory. At factories with annual production of more than 100 tons, the number of grinders increased together with plant size, but there was no direct relationship between tonnage and the number of units.

Further expansion of exports will require a more complete lineup of finishing machinery and equipment in order to meet the customers' requirement.

(5) Raw materials

The supply of raw materials to Malaysian foundries is unstable in terms of quality, quantity, and price.

According to the results of the questionnaires and factory visits, some very low-grade materials were being delivered to the foundries. Specifically, many pieces were too large, contained too much rust, or contained foreign substances and could therefore not be used. On the cost front as well, many interviewed were troubled by the increase in prices that has come about partially in response to rapidly increasing demand. As a result of this situation and the resulting uncertainty as to when ordered materials would arrive, practices such as early ordering and stockpiling have appeared on the steel scrap scene and are sources of concern to those in the business. Some companies have been forced to resort to surplus storage.

On the positive side, however, limestone, used to melt metals, is inexpensive and of good quality. In addition, high-quality silica moulding sand can be obtained from the Johor district, and recently high-silica sand with a silica content of at least 95% is being produced from the residual sand at tin mines. At present, tin mining sand has poor shape and grain size distribution, but it could become a rich resource if suppliers made the effort to bring it up to the quality standards of the industrialized nations.

Of the energy sources used for melting metals, only coke, used in cupola, is imported. The electrical power used by electric furnaces and the petroluem consumed by non-ferrous metal furnaces are provided locally. Electrical power in particular is relatively inexpensive: with the basic rate of M$12/kw plus the usage fee of 16 cents/kwh in the daytime and half that at night minus the 20% discount offered to industry, the final cost of electricity is 13-14 cents per kilowatt-hour (equivalent to about 7 yen), far less than the 18-22 yen rate typical in Japan.

Many factories used oil-powered generator motors to compensate for the lack of electrical power available for cast steel melting. Assuming a figure of M$0.5 per liter of petroleum and consumption of 58 l/hour for a 150-kw generator, petroleum consumption would amount to M$29 per hour. Electrical power would therefore cost M$29/150 = M$0.193/kwh (roughly 10 yen/kwh), roughly half the figure for Japan. (Note: These calculations were made based on data provided by the foundries visited.)

The conditions of the major raw materials are as follows.

1) Pig iron

Some of the foundries visited kept stocks of pig iron, but in fact it was seldom used at any of the facilities. This is due to a lack of basic knowledge of why pig iron is required in the manufacture of cast metal. More specifically, both buyers and producers were unaware that cast mechanical components must be capable of providing certain chemical, physical, and mechanical properties.

In Japan, for example, the mechanical and physical properties of cast (pig iron) mechanical components are specified by JIS. These have symbols such as FC 15, FC 20, and FC 30. Table III.2-20 shows the Japan Industrial Standards for gray cast iron. These figures are used in material tests, in which the dimensions of the test piece are specified by the material grade and wall thickness of the product. The foundry must produce products capable of fulfilling the needs laid out in the plans or specifications provided by the customer.

In order to produce gray cast iron meeting these material specifications, the Japan Foundrymen Society provides those in the industry with a list of target values for chemical composition. These values are shown in Table III.2-18.

Table III.2-18 Target Composition of Gray Cast Iron

Grade	T.C.	Si	Mn	P	S
FC 15	3.5~3.8	2.8~3.1	0.5~0.8	<0.25	<0.1
FC 20	3.3~3.6	2.3~1.8	0.6~0.9	<0.20	<0.1
FC 25	3.2~3.5	2.2~1.7	0.6~0.9	<0.15	<0.1
FC 30	3.1~3.3	2.1~1.6	0.6~0.9	<0.12	<0.1
FC 35	2.9~3.2	2.0~1.5	0.7~1.0	<0.10	<0.1

Source: Hand book, Japan Foundrymen Society

In Japan, the foundry decides upon a specific chemical composition based on the plans or specifications provided by the customer and then proceeds to calculate the necessary blend ratio of new pig iron, cast iron scrap, and steel scrap. The new pig iron content is generally similar to the one shown in Table III.2-19.

In contrast, chemical analysis of pig iron during the visits to Malaysian foundries indicated 3.3-3.5 total carbon and 1.4-1.6 Si contents, both of which are quite low. In addition, many products had non-uniform compositions and were therefore unusable.

Table III.2-19 Recommended Chemical Composition for Pig Iron

T.C.	Si	Mn	P	S
3.8~4.1	2.0~2.2	0.6~0.8	<0.15	<0.06

2) Cast iron scrap

Automobile engines appeared to be the most common source of cast iron scrap. This was followed by scrap from various types of light machinery. In general, these types of scrap are favorable because of their small wall thickness, which facilitates melting in a cupola or electric furnace. On the other hand, they tend to be plagued by an abundance of rust and the presence of impurities. When using this type of scrap, therefore, it is important to remove rust with a shot blasting machine and eliminate any foreign substances.

Table III.2-20 Japan Industrial Standard (JIS) for Gray Cast Iron

C.2.2 Cast iron products

a. JIS G 5501-1976 Gray cast iron

				Tension test	Breakage tests		Hardness test
Grade	Symbol	Common thicknesses mm	Diameter of test piece mm	Tensile strength kgf/mm2 (N/mm2)	Maximum load kgf(kN)	Flexure mm	Brinell hardness Hp
1	FC 10	4~50	30	10~ (98.1~)	700~ (6,860~)	3.5~	~201
2	FC 15	4~8	13	19~ (186~)	180~ (1,770~)	2.0~	~241
	9~15	20	17~	400~ (167~)	2.5~ (3,920~)	~223	
	16~30	30	15~	800~ (147~)	4.0~ (7,850~)	~212	
	30~50	45	13~	1,700~ (127~)	6.0~ (16,670~)	~201	
3	FC 20	4~8	13	24~ (235~)	200~ (1,960~)	2.0~	~255
	9~15	20	22~	450~ (216~)	3.0~ (4,410~)	~205	
	16~30	30	20~	900~ (196~)	4.5~ (8,830~)	~223	
	30~50	45	17~	2,000~ (167~)	6.5~ (19,610~)	~217	
4	FC 25	4~8	13	28~ (275~)	220~ (2,160~)	2.0~	~269
	9~15	20	26~	500~ (255~)	3.0~ (4,900~)	~248	
	16~30	30	25~	1,000 (245~)	5.0~ (9,810)	~241	
	30~50	45	22~	2,300~ (216~)	7.0~ (22,550~)	~229	
5	FC 30	8~15	20	31~ (304~)	550~ (5,394~)	3.5~	~269
	16~30	30	30~	1,100~ (291~)	5.5~ (10,790~)	~262	
	30~50	45	27~	2,600~ (265~)	7.5~ (25,500~)	~218	
6	FC 35	15~30	30	35~ (343~)	1,200~ (11,770~)	5.5~	~277
	30~50	45	32~	2,900~ (314~)	7.5~ (28,440~)	~269	

Notes
(1) Units and figures in parentheses are based on the International System of Units (SI) and are provided as reference. Note that 1 N/mm2 = 1 Mpa.
(2) Hardness tests are not performed unless there is a specific request from the purchaser. Mechanical tests are normally not performed on Grade 1 gray cast iron.
(3) Unless otherwise noted, the mechanical properties indicted are for a test piece ihanashi diameter of 30 mm.
(4) Common thicknesses and the mechanical properties of pieces with common thicknesses of less than 4 mm or more than 50 mm are determined based on agreements between purchaser and manufacturer.

3) Steel scrap

Virtually none of the cast iron foundries visited during the survey used steel scrap. Naturally, this was the main material used at cast steel foundries. Unfortunately, it often comes in shapes that are not suited to the size (inner diameter) of the melting furnace -- long, thin steel wire and excessively thick or thin plates, for example --resulting in thermal energy waste. It is common practice for scrap to be cut into pieces roughly one-third to one-fifth the inner diameter of the melting furnace.

4) Ferro-alloys

In order to allow ferro-alloys such as FeSi and FeMn to pass the material standards (e.g., JIS, BS, DIN, ASTM), a pretense is often made of calculating and adding the appropriate elements to the melting material. In fact, however, both buyers and producers pay relatively little consideration to this point, and as a result ferro-alloys are not being used meaningfully.

5) Silica moulding sand and additives

When correct knowledge and technical know-how are not applied during the use of moulding sand, there is the danger that numerous defects will be generated in the resulting product. In many of the operations visited there appeared to be no recognition of this very basic fact. Particularly in the case of green sand moulding, very few foundries performed reclamation of the moulding sand, and even at those that did insufficient control over the process negated any possible benefits. Ordinarily, bentonite, starch (dextrin or a heat-treated starch), or coal dust is added to the green mould sand, but at virtually all of the facilities visited operations were being conducted without knowledge of how much should be added. A lack of understanding of these additives and the objective behind them results in significant material waste.

Overall, the following conclusions can be drawn concerning materials. First, it is difficult to obtain new iron and steel scrap from key industries such as machinery, shipbuilding, iron and steel, and automobiles as well as cast iron and steel scrap from the market. Second, there is a dearth of material suppliers possessing any degree of expertise in the field. Finally, the foundries themselves lack accurate information concerning materials, and when they make uninformed material purchases they are, in a way, condemning the quality of their products. Particularly in the area of pricing, the practice of determining the quality grade of the material in question and then basing the price on this determination needs to be established.

(6) Standards

The MS standards are being drawn up through the deliberations of committees comprising representatives from related government bodies, academic organizations, commerce and industry organizations, and consumers. Standards for castings have also been determined by SIRIM as shown in the following list.

These deliberations will be continued in pursuit of improved quality.

Standards for the Casting Industry

Cast Iron Product				
[1]	CI Spigot Soil Pipes	MS 624	:	1980 (P)
[2]	Sluice Valves	MS 626	:	1980 (P)
[3]	Malleable C.I. Screwed Pipe Fittings for Steam, Air, Water an Oil	MS 638	:	1980 (P)
[4]	Grey Iron Pipes & Fittings	MS 708	:	1981
[5]	C.I. Non-pressure Pipes and Fittings	MS 709	:	1981
[6]	Double Flanged C.I. Wedge Gate (Sluice) Valves for Waterworks Purposes	MS 1049	:	1986
[7]	Cast Iron Fittings for Asbestos Cement Pressure Pipe	MS 1094	:	1987
Zinc Product				
[1]	Zinc Alloy Die Casting	MS 638	:	1980 (P)

Source: SIRIM

The main standards in use in Malaysia appear to be MS, BS, JIS, DIN, and ASTM. JIS is often used in day-to-day business. In fact, however, these standards are only being used for appearance's sake; it is hard to believe that they are actually being applied in any meaningful way. Tables III.2-21 through III.2-23 show the results of an investigation conducted to determine to what extent these standards were being applied.

Table III.2-21 Testing and Inspection at Malaysian Cast Iron Foundries

Production /year (tons)	No. of factories	Analysis of composition	Tensile strength	Hardness	Molten metal temperature measurement	CE measurement
<100	11	0	1	0	0	0
<300	27	0	0	1	0	0
<500	20	1	0	1	2	2
<1,000	11	0	0	0	2	2
<2,000	3 (1)	0	1	0	2	2
<3,000	1 (1)	1	2	1	2	2
>3,000	0	0	0	0	0	0
Total	73 (2)	2	4	3	8	8

Source: Questionnaires and factory visits

Table III.2-22 Testing and Inspection at Malaysian Steel Casting Foundries

Production /year (tons)	No. of factories	Analysis of composition	Tensile strength	Hardness	Molten metal temperature measurement	CE measurement
<100	3	0	0	0	0	0
<300	1	1	1	1	1	1
<500	1	1	0	1	1	1
<1,000	3	1	0	1	3	2
<2,000	3	3	2	3	3	3
<3,000	0	0	0	0	0	0
>3,000	1	1	1	1	1	1
Total	12	7	4	7	9	8

Source: Questionnaires and factory visits

Table III.2-23 Testing and Inspection at Malaysian Non-ferrous Metal Casting Foundries

Production /year (tons)	No. of factories	Analysis of composition	Tensile strength	Hardness	Molten metal temperature measurement
<100	37	0	0	0	0
<300	9	0	0	0	1
<500	3	0	0	0	0
<1,000	2	0	0	0	0
Total	51	0	0	0	1

Source: Questionnaires and factory visits

One of the properties referred to in the standards is tensile strength. In the case of cast iron foundries, only four out of 75 factories (5.3%) performed tests for tensile strength on a daily basis. Three of these four were factories with annual production exceeding 1,000 tons. In the case of steel casting foundries, four out of 12, or 33.3%, performed such tests. None of the non-ferrous metal foundries engaged in this type of testing.

Chemical analysis is a common topic for all the materials used in cast metal and is absolutely necessary if products are to meet the standards for tensile stength described above. Despite this, virtually no such analysis is being performed except at steel casting foundries. Although pre-cast ingots with chemical compositions already meeting standards are sometimes used at non-ferrous metal foundries, this is no excuse for the lack of testing. During the manufacture of a manganese bronze ship propellor, for example, it is necessary to form a test piece from the test block attached to the propellor body and carry out tests for tensile strength, elongation, and hardness. In the present questionnaire, however, no mention of such tests was made by the respondents.

When firms were asked to evaluate how "standards" were being understood and implemented in the factory, one malleable cast iron foundry reported that Malaysian pipe fitting standards were vague and that it was having difficulty obtaining certification from the JKR. At other factories as well standards were being implemented less than thoroughly, and customers were being supplied with goods of inferior quality.

SIRIM should consult with buyers, manufacturers, and third-sector parties alike and work towards the development of MS as fast as possible.

III-2-4. Technical Standards

(1) Technical Management

As described in Table III.2-1 above, the main customers of Malaysian cast iron foundries are firms in the tin mining, palm oil, rubber, timber, and building materials fields, while there is relatively little demand from the automotive, agriculture, and marine fields. The same is true of cast steel foundries. The leading customers at copper alloy foundries are companies in the rubber, tin, marine, and building material industries, while for aluminum foundries tin, rubber, electrical equipment, building, and motorcycle-related firms are the greatest buyers. In other words, with the exception of die casting plants Malaysia's casting industry still remains dependent on traditional local industries. This situation is often reported to have hindered the development of the nation's casting industry.

This limitation of the market for cast metal has effectively delayed the modernization and mechanization of the industry. As described in the section on the moulding process, however, cement moulding has been adopted by cast iron foundries, CO_2 moulding and pepset moulding by cast steel foundries, and both types of processes at non-ferrous metal foundries. Thus the efforts of those in the industry, who have struggled to compensate for the technical disadvantage caused by a lack of demand, should not be overlooked.

One common method of evaluating technical standards is to determine at what level these technical standards are determined and implemented, i.e., by the workers themselves, by experienced foremen, or by engineers and management, and then to categorize and evaluate the casting operation.

In Japan, the days in which these decisions were made based on the experience and intuition of laborers under the guidance of a foreman and the support of engineers who had graduated from uiversity or technical schools are long gone. Since around 1935 Japanese industry has worked to change its management structure from a worker-guided model based on experience and "feel" to an engineer-guided model based on scientific plant management and theory complemented by the introduction of key technologies. This type of management system expanded throughout Japanese society and was supplemented and improvemed as necessary to vitalize the nation as a whole. Practices such as SQC, TQC were introduced in all factories and have been extremely effective.

Table III.2-24 shows the results of an investigation to determine who decides melting ratios and casting plans in Malaysian cast iron foundries. The Table shows, blend ratios for the melting melting materials were decided by engineers, managers, and owners 7.6% of the time, followed by the workers thesmelves (22.7%), and finally foremen (6.7%). Casting plans were most often decided by engineers, managers, and owners (41.0%), followed by workers (38.7%) and pattern makers (21.3%).

Table III.2-24 Engineering Decision Makers in Malaysian Cast Iron Foundries

		Melting material			Casting plan			
Production /year (tons)	No. of factories	Opera- tors	Fore- man	Engineer manager	Opera- tors	Fore- man	Engineer manager	Pattern maker
<100	11	4	0	7	9	0	1	1
<300	27	7	0	20	10	0	10	7
<500	20	3	4	13	7	0	8	5
<1,000	11	3	1	7	3	0	6	2
<2,000	3 (1)	0	0	3 (1)	0	0	3 (1)	0
<3,000	1 (1)	0	0	1 (1)	0	0	(1)	1
>3,000	0	0	0	0	0	0	0	0
Total	73 (2)	17	5	51 (2)	29	0	28 (2)	16

Source: Questionnaires and factory visits

Table III.2-25 shows the results of a similar survey taken concerning technical management in Malaysian steel casting foundries. As can be seen from the Table, aside from one small facility with annual production of less than 100 tons, all decisions concerning melting material blend ratios were made by engineers, managers, and owners. Identical results were obtained for casting plans, although six firms did respond that they relied on pattern makers as well.

Table III.2-25 Engineering Decision Makers in Malaysian Steel Casting Foundries

	Melting material				Casting plan			
Production /year (tons)	No. of factories	Workers	Fore-man	Engineer manager	Workers	Fore-man	Engineer manager	Pattern maker
<100	3	1	0	2	1	0	2	0
<300	1	0	0	1	0	0	1	0
<500	1	0	0	1	0	0	1	1
<1,000	3	0	0	3	0	0	3	3
<2,000	2	0	0	3	0	0	3	1
<3,000	0	0	0	0	0	0	0	0
>3,000	1	0	0	1	0	0	1	1
Total	11	1	0	11	1	0	11	6

Source: Questionnaires and factory visits

Results of similar surveys conducted for copper alloy foundries, aluminum foundries, and die casting plants are shown in Tables III.2-26, III.2-27, and III.2-28, respectively.

Table III.2-26 Engineering Decision Makers in Malaysian Copper Alloy Casting Foundries

	Melting material			Casting plan		
Production /year (tons)	No. of factories	Workers	Engineer manager	Workers	Engineer manager	Pattern maker
<100	16	1	15	5	11	1
<300	5	1	4	1	4	0
<500	0	0	0	0	0	0
Total	21	2	19	6	15	1

Source: Questionnaires and factory visits

Table III.2-27 Engineering Decision Makers in Malaysian Aluminum Casting Foundries

	Melting material			Casting plan		
Production /year (tons)	No. of factories	Workers	Engineer manager	Workers	Engineer manager	Pattern maker
<100	14	3	11	3	11	1
<300	0	0	0	0	0	0
Total	14	3	11	3	11	1

Source: Questionnaires and factory visits

Table III.2-28 Engineering Decision Makers in Malaysian Die Casting Foundries

	Melting material			Casting plan		
Production /year (tons)	No. of factories	Workers	Engineer manager	Workers	Engineer manager	Pattern maker
<100	7	1	6	1	6	—
<300	4	1	3	1	3	—
<500	3	0	3	0	3	—
<1,000	2	0	2	0	2	—
Total	16	2	14	2	14	—

Source: Questionnaires and factory visits

At copper alloy foundries, blend ratios were determined by engineers, managers, and owners at 19 plants and by the workers at two. At aluminum foundries and die casting factories, the two figures were 11 versus three and 14 versus two. In any case, it is clear that engineers, managers, and owners are generally responsible for determining melting material blend ratios.

In casting plans, these plans are determined by engineers, managers, and owners at 15 out of 21 copper alloy foundries versus the workers at six. For aluminum foundries and die casting factories the figures were 11 versus three and 14 versus two.

These Tables show that technical management over the melting and moulding processes is performed by the workers more often in cast iron foundries than in other types of foudries. From the viewpoint of technical standards, this is one of the factors delaying the rationalization, mechanization, and modernization of the industry.

It was often found during the plant visits that those actually in charge of production were not the managers and engineers but rather the workers themselves. To take an example, cupola furnace melting uses a low melting temperature of about 1430°C, and because this can lead to the generation of blow holes, sand inclusions and other defects in the products, it is necessary to increase the coke ratio from 10-11% to 13-14% and to use an appropriate amount of the base metal. Virtually all of the plants relying on the experience of factory workers were unaware of this, and not attempting to make any improvements. In many other cases management was seen to be hindering the solution of problems, such as the case in which cast good defects were clearly resulting from poor casting plans and yet the resolution of these defects was still entrusted to the workers at site.

The very basic understanding on the role of management would have to be established in Malaysia.

(2) Quality Standards

Although it is difficult to make precise evaluation on the quality standards of Malaysian cast metal, some judgements were made from these aspects of external appearance, materials, and defects.

1) External Appearance

For cast metals, a favorable external appearance constitutes a smooth surface and freedom from harmful defects. A surface inspection should be made before products are delivered to the customer.

During the course of the foundry visits, it was found that while products at two or three of the larger companies were acceptable, those at most of the cast iron foundries were unacceptable. This is due to the fact that the shot blast and turn blast machines were unable to remove baked-on sand, indicating a lack of basic knowledge and know-how concerning moulding sand and also suggesting that the vocational training institutions and schools in Malaysia are not putting efficient emphasis on this respect.

Steel casting foundries in Malaysia are generally of a larger scale than their cast iron counterparts. At these factories there appears to be adequate knowledge and know-how conerning materials and operations, and appropriate technologies are being introduced. In this sense, factory management is better than at the cast iron foundries. Malaysia's non-ferrous metal foundries generally have small production capacities, and few quality-related problems have appeared as yet.

2) Materials

Materials are another important factor in determining product quality. It is common practice for desired quality standards to be provided by the customer in the form of plans or specifications.

Malaysian foundries, and cast iron foundries in particular, appear to be unconcerned about material specifications. As described in Table III.2-23 above, virtually no product testing or inspection is carried out. This type of situation cannot help but breed distrust and insecurity on local casting products among customers.

3) Defects

a) Types of defects

The results of an investigation into defects at Malaysian foundries and countermeasures being taken in response will be described below. Table III.2-29 shows the frequency of defects at cast iron foundries.

As is seen from the Table, the most common defect at the 75 factories was blow holes, reported at 60 factories (80.0%), followed by sand inclusions, reported at 42 factories (56.0%), shrinkage, at 42 factories (56.0%), pin holes, at 38 factories (50.7%), slag inclusions, at 37 factories (49.3%), chill, at 34 factories (45.3%), misruns, at 31 factories (41.3%), and cracks, at 13 factories (17.3%).

The causes of these defects should be investigated using scientific quality statistics, but the following probable causes could be suggested:

[1] Molten metal-related
- Melting temperature too low: blow holes, pin holes, misruns
- Inappropriate materials: shrinkage, chill

[2] Moulding sand-related
- Excess sand moisture: blow holes, pin holes, misruns, chill
- Low strength: sand inclusions, blow holes

[3] Casting plan-related
- Gating system defects: sand inclusions, blow holes, shrinkage, slag inclusions

[4] Operation-related
- Poor mould pouring: sand inclusions, shrinkage

Table III.2-29 Defects at Malaysian Cast Iron Foundries

Production /year (tons)	No. of factories	Blow hole	Pin hole	Sand inclus.	Slag inclus.	Mis-run	Shrin-kage	Crack	Chill
<100	11	6	6	7	6	5	5	1	2
<300	27	27	12	14	12	10	15	5	13
<500	20	17	8	8	9	7	15	5	12
<1,000	11	8	10	9	9	6	4	1	7
<2,000	3 (1)	1	1	3	1	3	3	1	0
<3,000	1 (1)	1	1	1	0	0	0	0	0
>3,000	0	0	0	0	0	0	0	0	0
Total	73 (2)	60	38	42	37	31	42	13	34

Source: Questionnaires and factory visits

The knowledge for improved melting process, sand, and moulding techniques should be mastered as soon as possible in order to resolve these problems.

Table III.2-30 shows the frequency of defects at steel casting factories. Shirnkage was the most common defect, found at nine of the 12 factories, followed by blow holes, slag holes, and slag inclusions, at seven factories, and pin holes, sand inclusions, and misruns, at six.

Table III.2-30 Defects at Malaysian Steel Casting Foundries

Production /year (tons)	No. of factories	Blow hole	Pin hole	Sand inclus.	Slag inclus.	Mis-run	Shri-nkage	Crack	Chill	Blister
<100	3	2	3	2	1	1	2	0	—	0
<300	1	1	0	1	1	1	1	0	—	0
<500	1	0	0	0	1	0	1	0	—	0
<1,000	3	2	2	2	3	3	3	2	—	1
<2,000	3	2	1	1	1	1	2	0	—	0
<3,000	0	0	0	0	0	0	0	0	—	0
>3,000	1	0	0	0	0	0	0	0	—	0
Total	12	7	6	6	7	6	9	2	—	1

Source: Questionnaires and factory visits

These defects are believed to stem either from inappropriate moulding sand, casting plans, and materials or from a lack of skills or laziness on the part of operators. SQC should be implemented in order to resolve these problems.

Defects at copper alloy foundries, aluminum foundries, and die casting foundries are shown in Tables III.2-31, III.2-32, and III.2-33, respectively. The most common defects at copper alloy foundries were blow holes, found at 17 of the 21 factories, and shrinkage, found at 16. The former is due to improper deoxidation or excess moisture in the moulding sand; the latter, to excessively high casting temperatures or improper feeder head design.

Table III.2-31 Defects at Malaysian Copper Alloy Casting Foundries

Production /year (tons)	No. of factories	Blow hole	Pin hole	Sand inclus.	Slag inclus.	Mis-run	Shrin-kage	Crack
<100	16	12	7	6	4	4	11	2
<300	5	5	4	4	2	2	5	2
Total	21	17	11	10	6	6	16	4

Source: Questionnaires and factory visits

Table III.2-32 shows defects at aluminum foundries. Common defects at these facilities included blow holes, pin holes, shrinkage, and misruns. These are due mainly to improper degassing and excessively high melting temperatures. Greater mastery is needed in this areas.

Table III.2-32 Defects at Malaysian Aluminum Casting Foundries

Production /year (tons)	No. of factories	Blow hole	Pin hole	Sand inclus.	Slag inclus.	Mis-run	Shrin-kage	Crack
<100	14	11	10	8	6	9	11	1
<300	0	0	0	0	0	0	0	0
Total	14	11	10	8	6	9	11	1

Source: Questionnaires and plant visits

Aluminum die casting plants suffer from fewer defects than those using sand moulds because the moulds are metal and the die temperature is maintained at about 300°C. Defects at these plants are shown in Table III.2-33.

Table III.2-33 Defects at Malaysian Die Casting Foundries

Production /year (tons)	No. of factories	Blow hole	Pin hole	Sand inclus.	Slag inclus.	Mis-run	Shrin-kage	Crack
<100	7	4	2	0	0	1	2	0
<300	4	1	1	0	0	0	1	2
<500	3	0	0	0	0	0	0	0
<1,000	2	0	0	0	0	0	0	0
Total	16	5	3	0	0	1	3	2

Source: Questionnaires and factory visits

b) Percentage of defective products

As described above, defects are generated during the manufacturing process and sometimes render the product unfit for use. It is the responsibility of the manufacturer to keep these to an absolute minimum. The percentage of defective products, or rejects, was investigated for each of the materials.

Table III.2-34 shows the average percentage of rejects for cast iron goods. Because of the significant variations according to plant size, the averages were taken separately for each category. When broken down by type of mould, green sand moulds were found to produce the highest average percentage of defective products (8.1%). They were followed by cement moulds, with an average rate of 5.5%, and CO_2 moulds, with a rate of 3.0%.

When broken down according to plant size, those foundries with annual production falling in the ranges 500-1,000 tons and 1,000-2,000 tons had high percentages of rejects. This was due, however, to factories which had just started operation and as a result had reject rates as high as 30%.

Table III.2-34 Rate of Defects at Malaysian Cast Iron Foundries

(Units: Average reject rate(%)/No. of factories)

Production /year (tons)	No. of factories	Green sand moulds	CO_2 moulds	Cement moulds	Dry sand moulds	Pepset moulds	Centrifugal
<100	11	8.3/5	3.3/6	3.1/7	—	—	—
<300	27	3.5/7	4.2/7	6.1/22	—	—	—
<500	20	7.3/5	3.8/6	6.0/8	—	—	—
<1,000	11	13.0/3	—/3	5.7/9	—	—	—
<2,000	3 (1)	17.0/2 (1)	—/0	4.5/1	—	—	—
<3,000	1 (1)	3/ (1)	—/1	—/0	—	—	—
>3,000	0	0	0	0	—	—	—
Total	73 (2)	8.1/24	3.0/23	5.5/47	—	—	—

Source: Questionnaires and factory visits

Overall, these figures are quite acceptable. Unfortunately, however, products are sometimes passed through the inspections and sent to the customer despite numerous defects. When viewed by international standards, the percentage of defective products would probably be much higher.

Production of cast iron goods in 1988 totaled approximately 3,500 tons. If exports are to be expanded in the future, quality should be brought up to international levels as soon as possible.

When taken out of the moulds, steel casting goods actually contain more defects than cast iron, but since repair welding is accepted on an international basis the percentage of defective products is relatively low. Table III.2-35 shows the rate of defective products at Malaysian cast steel foundries.

Those factories with annual production in the range 500-1,000 tons have the highest reject rate, at 20%. The most common defects at this facility were blow holes and shrinkage. These defects are thought to be due to inappropriate casting plans and a high moisture content (6-7%) in the moulding sand. Possible solutions would be to limit the moisture content to 4% by adding 0.2% - 0.5% dextrine to the moulding sand and to improve the gating system.

The factory with the lowest percentage of rejects had annual production exceeding 3,000 tons. Products from this foundry were of excellent quality.

Tables III.2-36 through III.2-38 show the percentage of rejects at non-ferrous metal foundries. Rates of defective products at these foundries ranged from 1% to 20% with no relation to the size of the plant.

Table III.2-35 Reject Rate at Malaysian Steel Casting Foundries

(Units: Average reject rate(%)/No. of factories)

Production /year (tons)	No. of factories	Green sand moulds	CO_2 moulds	Cement moulds	Pepset
<100	3	—/1	4/3	5/1	/0
<300	1	—/1	5/2	—/1	/0
<500	1	—/0	2.5/1	—/1	/0
<1,000	3	20/1	6.1/2	—/0	/0
<2,000	3	—/0	3.1/1 (1)	—/0	—/1
<3,000	0	—/0	—/0	—/0	0
>3,000	1	—/0	0.1/1	—/0	0.1/1
Total	12	6.7/3	3.3/10	5/3	—/2

Source: Questionnaires and factory visits

Table III.2-36 Reject Rate at Malaysian Copper Alloy Casting Foundries

(Units: Average reject rate(%)/No. of factories)

Production /year (tons)	No. of factories	Green sand moulds	CO_2 moulds	Cement moulds	Dry sand moulds
<100	16	4.2/16	9/3	6.8/3	—
<300	5	3.1/5	4.3/3	4.1/3	—
Total	21	3.9/21	6.7/6	5.5/6	—

Source: Questionnaires and factory visits
Units: Reject rate/no. of factories

Table III.2-37 Reject Rate at Malaysian Aluminum Casting Foundries

(Units: Average reject rate(%)/No. of factories)

Production /year (tons)	No. of factories	Green sand moulds	CO_2 moulds	Cement moulds	Dry sand moulds
<100	14	4.3/14	7.5/3	/0	—
<300	0	—	—	—	—
Total	14	4.3/14	7.5/3	—/0	—

Source: Questionnaires and factory visits

Table III.2-38 Reject Rate at Malaysian Die Casting Foundries

(Units: Average reject rate(%)/No. of factories)

Production/year (tons)	No. of factories	Metal dies
<100	7	4.1/7
<300	4	7.0/4
<500	3	6.5/3
<1,000	2	5.3/2
Total	16	5.4/16

Source: Questionnaires and factory visits

(3) Testing and Inspection

Quality improvement at Malaysian foundries will require standardization of materials and operations, the preparation of manuals for machinery, and thorough in-process checks. In other words, constant and thoroughgoing quality control activities are needed.

An investigation was made to what extent and in what ways the items critical to product quality -- molten metal temperature and composition, moulding sand, mechanical characteristics of the cast metal, etc. -- were being tested and inspected.

Table III.2-39 Testing and Inspection of Molten Metal, Moulding Sand, and Materials at Malaysian Cast Iron Foundries

(Unit: No. of factories testing)

		Moulding sand	Molten metal		Materials
Production /year (tons)	No. of factories	Pressure resistance, ventilation, etc.	Temperature	Composition	Mechanical tests
<100	11	1	2	1	1
<300	27	5	7	2	5
<500	20	2	5	3	8
<1,000	11	2	2	1	4
<2,000	3 (1)	2 (1)	3 (1)	3 (1)	3 (1)
<3,000	1 (1)	1 (1)	1 (1)	1 (1)	1 (1)
>3,000	0	0	0	0	0
Total	73 (2)	13 (2)	19 (2)	11 (2)	22 (2)

Source: Questionnaires and factory visits

Table III.2-39 shows that only about 20% of all cast iron foundries were engaged in the testing of moulding sand pressure resistance and ventilation. 21 factories (28.0%) checked molten metal temperature; 13 factories (17.3%), molten metal composition; and 22 (32.0%), mechanical properties of the materials used. The frequency with which these checks are performed is unclear, but during the factory visits it appeared to be quite low.

Table III.2-40 shows the frequency of testing at steel casting foundries in Malaysia. Three out of the 12 facilities (25%) test moulding sand; 10 (83.3%), molten metal temperature; eight (66.7%), molten metal composition; and 10 (83.3%), the mechanical properties of the materials used. These figures are significantly higher than those obtained at cast iron foundries.

Testing and inspection at non-ferrous metal foundries is summarized in Tables III.2-41 through III.2-43. The Tables show that inspection of material properties is most common at these plants, followed by measurement of molten metal temperature. Those firms not checking the temperature are thought to control temperature based on experience, but the use of measuring instruments would allow reduction of metal oxidation and hydrogen gas absorption as well as energy savings.

Table III.2-40 Testing and Inspection of Molten Metal, Moulding Sand, and Materials at Malaysian Steel Casting Foundries

(Unit: No. of factories testing)

Production /year (tons)	No. of factories	Moulding sand: Tensile resistance, ventilation, etc.	Molten metal: Temperature	Molten metal: Composition	Materials: Mechanical tests
<100	3	0	1	0	1
<300	1	0	1	1	1
<500	1	1	1	1	1
<1,000	3	0	3	3	3
<2,000	3	1	3	2	3
<3,000	0	0	0	0	0
>3,000	1	1	1	1	1
Total	12	3	10	8	10

Source: Questionnaires and factory visits

Table III.2-41 Testing and Inspection of Molten Metal, Moulding Sand, and Materials at Malaysian Copper Alloy Casting Foundries

(Unit: No. of factories testing)

		Moulding sand	Molten metal		Materials
Production /year (tons)	No. of factories	Tensile resistance, ventilation, etc.	Temperature	Composition	Mechanical tests
<100	16	2	7	1	10
<300	5	0	2	0	0
Total	21	2	9	1	10

Source: Questionnaires and factory visits

Table III.2-42 Testing and Inspection of Molten Metal, Moulding Sand, and Materials at Malaysian Aluminum Casting Foundries

(Unit: No. of factories testing)

		Moulding sand	Molten metal		Materials
Production /year (tons)	No. of factories	Tensile resistance, ventilation, etc.	Temperature	Composition	Mechanical tests
<100	14	2	6	0	7
<300	0	0	0	0	0
Total	14	2	6	0	7

Source: Questionnaires and factory visits

Table III.2-43 Testing and Inspection of Molten Metal and Materials at Malaysian Die Casting Foundries

(Unit: No. of factories testing)

		Molten metal		Materials
Production /year (tons)	No. of factories	Temperature	Composition	Mechanical tests
<100	7	4	0	3
<300	4	2	0	1
<500	3	2	0	1
<1,000	2	2	0	1
Total	16	10	0	6

Source: Questionnaires and factory visits

III-2-5. Business Administration

(1) Corporate Structure and Size

1) Corpoate structure

Of the 110 factories which answered questionnaires or were interviewed in the current survey, more than half were joint-stock companies whose names were followed by either SDN BHD ("Sendrian Berhad" -- private company) or BHD (public company). The remainder included limited partnerships and privately-owned companies.

Table III.2-44 Breakdown of Companies by Corporate Structure

Capital structure	No. of factories	Percentage of total (%)
Joint-stock company	57 (54 private companies) (3 public-companies)	52 (49 private companies) (3 public-stock companies)
Other	53	48
Total	110	100

Source: Questionnaire and interviews

2) Capitalization

Table III.2-45 shows a breakdown of the plants surveyed according to capitalization.

Table III.2-45 Capitalization

Paid-in capital (M$1,000)	No. of factories	No. of factories receiving foreign assistance
5,001~10,000	3	2
1,001~5,000	10	6
50~1,000	8	—
~500	86	2
Total	107	10

Source: Questionnaires and interviews
Note: These figures exclude HICOM Diecastings Sdn. Bhd. together with two firms whose main area of business is not casting.

As the Table shows, fully 80% of the companies surveyed are concentrated in the under-M$500,000 range. In contrast, 12 firms, representing 12% of the total, had paid-in capital exceeding M$1 million. The three firms capitalized at more than M$5 million. They consist of a firm which manufactures pipe fittings, a firm which engaged in steel rolling as well as castings, and a company which belongs to a group consisting of firms in a variety of industries.

The study on the extent of foreign-capital assistance shows that only two of the small-scale companies had received such assistance, while many factories capitalized at M$1-5 million had received infusions of foreign capital. Major sources of such assistance included companies in Japan, Singapore, Taiwan, and Indonesia, with firms in Singapore and Taiwan providing the greatest amounts.

3) Number of employees

Table III.2-46 shows a breakdown of companies according to the number of employees. As can be seen from the Table, 77 of the factories, or 70% of the total, had fewer than 30 employees, with only six facilities having more than 100 workers.

Table III.2-46 Breakdown of Factories by Number of Employees

No. of employees	No. of factories		Percentage of total (%)
2~10	38		
11~20	26	77	70
21~30	13		
31~40	6		
41~50	7		
51~100	14	33	30
101~235	6		

Source: Questionnaire and interviews

Joint-stock companies on the average had about 3.5 times as many employees as other companies. The average number of employees for both types is shown in Table III.2-47.

Table III.2-47 Average Number of Employees

Corporate structure	Average no. of employees
Joint-stock	48
Other	14
Average	32

Source: Questionnaire and interviews
Note: The number of employees includes those in both casting and machining. Rolling and other processes not directly related are not included.

4) Breakdown of factory size by material

The six large factories having at least 100 employees included two manufacturer of cast iron, two of steel casting, one mass-producer of pipe fittings and one die casting firm. In contrast, cast iron and alloy foundries were usually smaller operations, nearly half being privately owned and managed.

5) Factory size (floor space)

77 foundries had floor space of less than 2,000 m^2. The 77 facilities had a combined floor space of 61,513 m^2, resulting in an average of approximately 800 m^2.

6) Reliance on casting production

One of the characteristics of foundries in Malaysia is the fact that they are mostly exclusive manufacturers of casting products. Of the factories interviewed in the current survey, however, one was engaged in the manufacture of bar steel using steel rolling, and another was producing castings for use as electrical appliance components together with the manufacture of casting products.

7) Machining

Ordinarily, castings are shipped after being machined, with no pieces being shipped "as cast." All but one of the facilities visited had machining facilities. The one exception relied on outside firms for its machining.

In addition, some companies possessed a variety of machine tools and used them in processing their own castings and assembling simple pieces of equipment, such as rubber creaping machines. In general, however, these machine tools were not of high precision. At present, the cost of such precision machine tools are too high for most companies to modernize them.

In the future, however, high-performance machine tools would become indispensable if companies are to supply parts to modern industries such as the automobile and machinery sectors.

8) Melting frequency

Most companies surveyed carried out the melting operation once or twice a month. Table III.2-48 summarizes interview results concerning cupola furnace melting frequency.

Foundries with a high melting frequency are often those engaged in mass production of pipe fittings, etc., while those with a low melting frequency are usually engaged in job-based manufacture.

Table III.2-48 Cupola Furnace Melting Frequency (monthly)

Melting frequency	Daily	8 times	3 times	2 times	1 times	0.5 times	Total
No. of factories	3	1	1	5	2	1	13
Total	4		9				

Source: Interviews

(2) Factory Location

Malaysian foundries are concentrated around Ipoh in the Perak district and around Kuala Lumpur. Both areas are important tin-producing districts, indicating the historical dependence of the casting industry on work from the tin industry.

There is not casting company in Eastern Malaysia. With the exception of small-scale operations producing souveniors using the lost-wax technique in Trengganu province along the eastern coast, there are no foundries engaged in casting production in Western Malaysia either.

Many of the small foundries concentrated around Ipoh and Kuala Lumpur remain dependent on traditional industries such as tin and palm oil.

In contrast, the larger factories, such as one in Ipoh employing 235 people and one in Selangor employing 90, tend to be located in Malacca and Johor . Foundries in both areas are often found on TOL (Temporary Occupied Land), and studies on a proposal to establish foundry engineering parks for the casting industry are steadily proceeding.

The following is a summary of answers from each casting firm to questions concerning attitudes on moving their operations to the proposed foundry parks, the reasons therefor, and additional comments and suggestions.

Table III.2-49 Desire to Move to the Foundry Parks

	No. of factories	Current location					
		Kuala Lumpur	Selangor	Perak	Malacca	Johor	Penang
Yes	77	44	15	18			
No	11	2	2	3	2	2	
Other	2				1		1
Total	90	46	17	21	3	2	1

Source: Questionnaires (103 respondents with 90 valid responses)

Table III.2-49 shows that an overwhelming majority of the firms surveyed expressed a desire to move their operations to the new foundry parks. Those not interested were currently located in Malacca, Johor, and areas distant from urban centres.

Table III.2-50 tabulates the reasons offered for wanting to move.

Table III.2-50 Reasons for Moving to the Parks

Reasons	No. of firms	Subtotals
Land/building-related		
Current lot is TOL	20	
Current lot is too small	13	38
Current building is too small	5	
Production-related		
To expand production	12	20
Deterioration of current facilities	8	
Environment-related		
Unreliable or insufficient supply of water and electricity	8	
Pollution-related complaints	6	23
Poor road access	6	
Poor water treatment facilities	3	
Other		
Company policy, etc.	6	6
Total		87

Source: Questionnaires (Answers from the 77 firms expressing the desire for relocation. Multiple responses were permitted.)

As can be seen from Table III.2-50, the most frequently given reason was that the present factory is located on TOL. Another common reason, however, was the desire to expand production. Since reasons such as small lot size, insufficient floor space, and other production-related factors can also be taken as a desire to expand existing operations, a total of 38 firms expressed the desire to expand current operations as their reason for moving to the parks, far more than those indicating TOL as their reason.

A total of 23 firms expressed dissatisfaction with the surrounding infrastructure of their present locations.

Table III.2-51 provides a summary of suggestions and requests made by the companies with respect to the new foundry parks.

Table III.2-51 Suggestions and Requests Concerning the Parks

Reasons	No. of firms	Subtotals
Land/building site-related		
That the park be located near Kuala Lumpur	58	75
That the park be located near Ipoh	17	
Production-related		
That the park provide a variety of functions	20	
	4	28
That transportation convenience be improved	2	
That facilities for joint use be made available	2	
Purchasing conditions-related		
That land prices be kept down	68	
That installment payments be allowed for lots in the parks	29	107
That payments for the lots be spread over three years	10	
Other		
Desire to receive public financing	7	7
Total	217	

Source: Questionnaires (Answers from the 77 firms expressing the desire for relocation. Multiple responses were allowed.)

(3) Fund Raising

Virtually all of these foundries are locally-capitalized small businesses. The great majority of factories have used funds raised during the past two years as operating capital. In addition, most of these funds have been raised from individuals, with only one factory receiving foreign capital assistance during the same period. A large number of factories plan to use funds raised during the next two years as operating capital, with equipment expansion being the most common destination.

It is clear that factories are looking to public financial institutions as suppliers of funds for the construction of new plants. This can be seen from Table III.2-52.

Table III.2-52 Intended Uses and Prospective Suppliers of Funding

	Past 2 years	Plans for the next 2 years	Increase in (2) over (1)
Intended use			
Operating capital for increased sales	18	61	3 times
Expansion/renovation of equipment and facilities	16	65	4
New plant construction	6	52	8.6
New product development	7	21	3
Other	7	4	
Prospective supplier			
Domestic			
Public financial institutions	7	52	7.4
Private financial institutions	1	4	
Private companies or individuals	12	4	
Other	2	3	
Overseas	1	2	

Source: Questionnaires (103 respondents)

Many factories reported great difficulty in raising funds. It was repeatedly expressed during the interviews that the relocation of operations to the industrial parks will generate the need for further funds, and it was hoped that something be done about this. The main problems associated with fund-raising, as shown in Table III.2-53, were high interest rates and excessive collateral requirements.

Table III.2-53 Reasons for Difficulty in Raising Funds

Reasons	No. of firms
Conditions of borrowing	
High interest rates	83
Collateral requirements	83
Loan requirements	44
Limitations on amount	35
Guarantee from a parent company required	32
Procedures	
Long time required for consideration	78
Complicated procedures	78
Lack of knowledge concerning loans	43
No access to the international credit market	17
Other	4

Source: Questionnaires (103 respondents)

(4) Manpower Training

Tables III.2-54 and III.2-55 show the composition of the workforce at Malaysian foundries.

Table III.2-54 Employee Age and Years of Service

		Factory workers	
	Staff	Skilled	Unskilled
Average age	34	36	28
Average years employed	11	9	5

Source: Questionnaires (averages taken from valid responses)

Table III.2-55 Educational Background of Employees

Education	Staff	Factory workers	
		Skilled	Unskilled
Primary School	11%	44%	53%
Lower Secondary School	17	43	46
Upper Secondary School	65	13	1
University/College	7	0	0
Total	100%	100%	100%

Source: Questionnaires (calculated from valid responses)

While a comparison of staff and skilled workers shows no significant difference in the average age and length of service of white-collar staff and skilled workers, a major break could be viewed in the area of education: while 65% of all white-collar staff had finished upper secondary school, only 13% of the skilled workers and 1% of the non-skilled workers had done the same.

As shown in Table III.2-56, in-house training is by far the most common type of training offered to employees, with few companies providing workers with opportunities for outside training.

Table III.2-56 Employee Training

	In-house training	Outside training
Offered	90	14
Not offered	13	89

Source: Questionnaires

On-the-job training was the most frequent type of in-house training, and only two large companies carried out any sort of systematic training. In addition, only large firms responded that they provided training "when necessary." Concerning on-the-job training, many felt that since there are few company employees capable of serving as instructors not much could be expected from them.

Table III.2-57 Current and Scheduled In-house Training

	No. of firms
On-the-job training	86
Provided when necessary	10
Provided systematically	2

Source: Questionnaires

Compared with in-house training, far fewer firms provided employees with outside training. As can be seen from Table III.2-58, only four companies offered employees opportunities for overseas training in 1988.

Table III.2-58 Outside Training Destinations (in 1988)

Destination	No. of firms	Remarks
Public institution		
CIAST	7	Centre for Instructor and Advanced Skill Training
SIRIM	2	Standard and Industrial Research Institute of Malaysia
ITI	1	Industrial Training Institute
Overseas, etc.	5	Four foreign firms

Source: Questionnaires (responses from 14 firms providing outside training)

In addition to those listed in Table III.2-58, there are such other educational and training institutes as IKM (Institut Kemahiran MARA) and TAR College (Tunku Abdul Rahman College), in Malaysia.

It was informed that ITI is not providing training courses of casting at present, although programmes are scheduled to resume in 1990. CIAST offers a Foundry and Casting course, but the number of their participants is reported to be still small. Since its establishment in 1985, the number of graduates of the casting course at CIAST reached 51 (as of June 1989). But the existence of the CIAST or the course or foundry in CIAST is not yet well known any some casting factories.

IKM is engaged in the training of general technicians and has produced 250 graduates since its foundation in 1977. Each year 28 students graduate from the casting course, but not all of these seek employment in foundries complains were observed from some foundry managers that after finishing the training course many students are not willing to work at foundry plants.

The views of foundry managers with regard to the problem areas in training programmes and other aspects of labour management were investigated. The results are as shown in Table III.2-59.

Table III.2-59 Labour Management Problems

Problem	No. of firms	Percentage of total
Shortage of engineers	72	85%
Rapidly increasing wages	41	48
High separation rate (Job hopping)	38	45
Shortage of workers	28	33
Difficulty of negotiating with labour	9	11
High fringe benefits	6	7
Increased cost of training programmes	4	5
Other	2	2

Source: Questionnaires
Note: Responses were obtained from 85 factories.

The most frequently-noted problem in labour management was the shortage of engineers, indicated by 72 factories, or 85% of the total. The next most common problems were wage increases and high separation rates. Table III.2-60 summarizes the types of assistance these managers expect from the government on the personnel field.

Table III.2-60 Assistance Expected from the Government

	No. of firms	Percentage of total
1. On-the-job training by foreign experts	72	85%
2. Expansion of public training facilities	41	48
3. Subsidies for training	38	45
4. More frequent sponsoring of technical seminars	28	33
5. Dispatch of instructors from public institutions	9	11
6. Skills training for workers	6	7

Source: Questionnaires
Note: Responses were obtained form 92 factories.

More than 80% of the responding firms are looking towards foreign experts not just for theoretical instruction but for practical assistance in solving production problems at site. It was also suggested during the interviews that some of the current instructors are lacking in practical experience.

Reexamination of current curriculums in casting training courses would also be needed from the standpoint of emphasizing practicality. Some companies requested that short-term, intensive courses be held since long periods of training are impractical for small plants, which cannot afford to send workers for long periods of training.

Recently, younger Malaysian workers are showing a preference towards comanies offering a clean workplace with better wages and other conditions as in any other countries.

However, there is a prevalent image that most foundries are dirty and hot.and its work involves heavy labour. Thus, the common opinion was that it is difficult to hire ordinary workers.` The industry would have to work to dispel these negative images, for which there remains great room for improvement of the plant working environment.

(5) Management

In the questionnaire sheet, 20 management-related items were presented, and respondents were asked to rank the 15 in which they had the most interest or concern.

The numbers in Table III.2-61 were obtained by assigning 15 points to the highest-ranked item, 14 to the next-highest-ranked item, and so on, and then dividing the total for each item by the number of respondents.

The items will be listed in order of the interest expressed.

Table III.2-61 Management-related Items of Concern/Interest

1 .	Utilization of government incentives	11
2 .	Quality improvement	8
3 .	Expansion of production	8
4 .	Securing of funds	8
5 .	Procurement of high-quality, low-cost raw materials	8
6 .	Cost reductions	8
7 .	Reduction of the defect rate	7
8 .	Hiring of good workers	7
9 .	Modernization of equipment and facilities	7
10 .	Stronger market development efforts	7
11 .	Acquisition of technical information	6
12 .	Improvement of productivity	6
13 .	Training of workers	5
14 .	Use of local raw materials	3
15 .	Acquisition of overseas market information	3
16 .	Introduction of new technologies	3
17 .	Expansion of exports	3
18 .	Development of high-added-value products	2
19 .	Greater development efforts	2
20 .	Shortening of delivery times	1

Souce: Questionnaires
Note: The numbers are averages taken from all 67 respondents.

The following remarks can be made concerning Fig. III.2-61:

1) Utilization of government incentives was ranked highest. At large factories, however, it was ranked low.
2) At large factories, the improvement of quality and productivity and the reduction of costs were highly ranked. The smaller the operation, however, the less the interest shown in these areas.
3) Despite concern about quality improvement and reduction of the defect rate, there was little interest shown in such practical counter measures as the technology introduction and development in these areas.
4) The recreutment of high-quality and low-cost raw materials are considered to be the principal means of cutting costs.
5) All of the factories showed considerable interest in expanding production.
6) Although the procurement of funds was highly ranked among small and medium-sized firms, the larger operations were not particularly concerned.
7) The smaller the size of the operation, the greater the interest shown in the hiring of good workers.
8) The modernization of equipment and facilities is being viewed as a problem more among smaller companies than by the larger operations.
9) Little interest was shown with respect to acquiring information concerning export expansion and overseas markets.
10) Factories are under the impression that current delivery schedules are adequate.

Despite the interest shown in quality improvement, actual activities such as QC circles and the proposal system in particular were not being undertaken at casting plants, as shown in Table III.2-62.

Table III.2-62 QC Circles and the Proposal System

	Have adopted	Not adopted	Remarks
QC circles	11	90	Average of 3 circles per company
Proposal system	19	78	Average of 8 proposals/company in 1988

Source: Questionnaires

Table III.2-63 Employee Morale

	No. of plants	Evaluation of factories visited
Very high	1	0
Fairly high	14	5
Ordinary	74	16
Fairly low	6	1
Very low	7	1
Total	102	

Source: Questionnaires and interviews
Note: The 23 companies visited were included in the total number of plants.

Based on the results of both the questionnaires and interviews, employee morale was neither particularly high nor low. As work proceeds on modernization of the industry, this would become a more severe problem area that will have to be dealt with.

III-2-6. Peripheral Industries

(1) Raw Materials

Table III.2-64 shows the results of a survey on procurement of the raw materials used in casting.

The main raw materials which can be procured locally are sand, cement, and scrap metal.

Table III.2-64 Raw Material Procurement

	Material	Source		Suppliers	Ease of procurement		Quality	
		Local	Overseas		Easy	Difficult	Good	Poor
1.	Pig iron	Δ	O	China, Brazil, Australia, Taiwan	6	7	5	7
2.	Iron scrap	O			2	9	3	3
3.	Steel scrap	O			2	2	3	
4.	Cu ingot		O	U.K., Australia, China	4		8	
5.	Cu scrap	O					1	
6.	Al ingot		O	U.K., Australia, Taiwan, Singapore	2		2	
7.	Al scrap	O					3	1
8.	Zn ingot		O	Australia, Taiwan				
9.	Fe-Si		O	China, Norway, Taiwan	8		8	12
10.	Fe-Mn		O	Norway, Australia, Singapore	2	2	9	
11.	Coke		O	Japan, China, Taiwan, Australia	12	3	14	6
12.	Silica sand	O			23		7	4
13.	Bentonite		O	U.S., Australia, China	3	3	9	5
14.	Sodium silicate	O			15		8	
15.	Cement	O			38		12	

Source: Questionnaires
Symbols: O: Mainly sourced; Δ: Partially sourced
Note: Evaluations of the ease of procurement and quality represent the number of companies (out of 103) which responded accordingly in the questionnaire survey.

Most factories are of the opinion that silica sand, sodium, silicate, and cement are easy to obtain.

Malaysia has abundant deposits of good silica sand with a high silica content. At present, deposits have been discovered in southeast Johor, Trengganu, Sarawak, and Perak. Foundries requiring high-quality sand can turn to Johor products, but the price is high, at M$100 per ton. Sand from the Trengganu and Sarawak regions is not being used at present because of transportation difficulties.

Abandoned tin mines are also an excellent source of silica sand. This variety, referred to as tin mining sand, is sold on the market for about M$80/ton. Tin mining sand taken from Kundang in the Rawang district north of Kuala Lumpur is referred to as "Kundang sand."

Natural sand and mountain sand are generally of poor quality, but some factories make use of them because of their low cost, which is currently around M$10/ton. "River sand" is also available, but this is used mainly in the filtering of water.

The resin-coated sand used in shell moulding to fabricate cores is used by two pipe fitting manufacturers, and these firms sell the sand to other companies as well. The price is about M$500/ton. Some of this sand is imported from Taiwan.

Cement is easy to obtain because of the production of large amounts of limestone along the western coast of Western Malaysia.

Iron scrap, on the other hand, is one the materials said to be difficult to obtain. Although few of the companies indicated any problems at present, the increase of demand by general good economic condition in Malaysia tends to send prices high, and some companies are preparing for these conditions by stockpiling.

Fe-Si, noted by 12 firms, was the material with the most quality-related problems. China is the main supplier. China was also the main supplier of pig iron, another problematic material, while locally-produced pig iron was indicated by only one firm. Since Malaysian pig iron generally has a low Si content, it is used at only a few facilities.

Japanese coke was indicated as being the highest-quality available. It was also the most expensive, however, with current prices in the M$900-1,000/ton range.

A relatively long time power stoppage during the melting process would create a big problem of hardening of the molten metal in the furnace. As a result, stable supplies of electrical power are necessary. Due to this some companies that can not obtain enough power are forced to use their own generators. In the responses of to questionnaire survey, however, no significant problems were noted in this area.

(2) Casting Operations

1) Machining

The production process for castings, from melting to final finishing, is generally carried out within the same factory. A small number of operations contract out portions of the production process, but the dependence on such subcontracting as viewed by the ratio of subcontracting fees to sales is very low, at 5% (although one firm showed a figure of 27%).

Table III.2-65 Types and Extent of Subcontracting

Operation	No. of companies	Remarks
Machining	9	
Assembly	1	Assembly of machines for sale to other companies
Painting	3	
Chrome plating	1	Diecast products
Finishing	1	Deburring

Source: Questionnaires (103 respondents)

2) Wooden pattern

There are said to be 12 wooden pattern makers across Malaysia with 12-13 employees. Some smaller operations with only two or three workers also exist. A factory visited in Kuala Lumpur was said to be the largest, with 15 employees. In addition to wooden pattern for use in casting, this facility was engaged in the production of wooden moulds for use with plastics and glass as well.

Concerning casting plans, the technology exists at these plants to design simple moulds for steel casting but pattern for ductile materials and aluminium alloys are said to be too difficult to produce. Materials being used include hard Tingai wood and the soft Jaraton variety.

Most of the large foundries visited had their own pattern shops. One of the factories had a computer-managed shop with a staff of 10 and several thousand wooden pattern in stock. This factory reported that the technical level of wooden pattern makers is still low.

3) Analysis and testing

Analysis and testing equipment is possessed by the larger factories but is entirely lacking at the smaller operations. Spectrometers, used for chemical analysis of samples, were found at only two of the large companies visited, with one more factory considering the purchase of one of these devices. When necessary, other factories sometimes sent their samples to one of these firms for testing.

There are said to be two private companies carrying out analysis, and the silica sand manufacturers also made use of them. SIRIM is equipped with analysis and testing devices and is utilized by some of the companies.

III-3. World Markets

III-3-1. World Market Scale

The 1987 world market for castings was estimated from supply statistics at roughly 45 million tons.

With the exception of the Soviet Union, the world can be broken down into three major markets — the U.S., Europe and Asia (excluding China) — each accounting for roughly 22% of the total market.

Fig. III.3-1 Regional Shares of Production of Castings in 1987

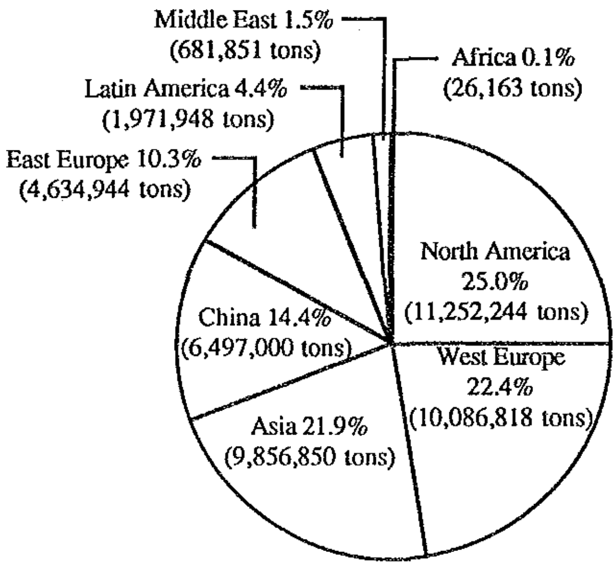


Table III.3-1 Worldwide Production of Castings in 1987

Country/region	1987 production (tons)	Share (%)	Percentage of cast iron
North America	11,252,244	25.0	
U.S.A.	10,327,453	(22.9)	75.6
Canada	924,791		90.9
West Europe	10,086,818	22.4	
U.K.	1,401,600	(3.1)	70.8
West Germany	2,373,798	(5.3)	—
France	2,047,389	(4.5)	80.4
Italy	1,927,932	(4.3)	68.5
Spain	811,000		71.2
Sweden	346,000		82.4
Switzerland	203,425		90.4
Denmark	75,540		100.0
Finland	109,951		78.4
Austria	192,567		65.6
Holland	234,700		90.5
Norway	66,804		83.2
Belgium	208,420		64.2
Portugal	87,692		69.4
East Europe	4,634,944	10.3	
East Germany	1,170,000	(2.6)	78.2
Hungary	281,301		73.0
Poland	1,724,000	(3.8)	84.0
Czechoslovakia	1,459,643	(3.2)	71.1
Asia	16,353,850	36.3	
China	6,497,000	(14.4)	77.0
Taiwan	1,059,594	(2.4)	79.7
Japan	6,623,372	(14.7)	75.2
Korea	1,068,000	(2.4)	82.2
Philippines*	120,000		
Thailand*	120,000		
Malaysia	55,884 (Note 1)		
Indonesia*	60,000		
Singapore	40,000 (Note 2)		
Hong Kong*	80,000		
India*	400,000		
Bangladesh*	100,000		
Pakistan*	120,000		
Sri Lanka*	2,000		
	8,000		
Latin America	1,971,948	4.4	
Brazil	1,529,600		83.3
Mexico	404,648		80.0
Peru	37,700		
Middle East	681,851	1.5	
Egypt	81,881		66.4
Turkey	571,100		83.0
Israel	28,870		58.2
Africa	26,163	0.1	
Zambia	26,163		
Total	45,007,818	100.0	

Sources: *Modern Casting*, December 1988. Figures for those nations indicated with an asterisk were obtained at APO and JPC casting technology seminars.

Notes:
1. Production estimate for 1988 made by the JICA study team.
2. Based on the results of a third-country survey implemented as part of the development survey. The figure indicates production of cast steel and pig iron in 1989.

Table III.3-2 Production of Castings in the Asian NIEs and ASEAN Nations for 1987

(Unit: tons)

Country/region	Production	Share of Asian NIEs/ASEAN production	Share of production by 8 Asian nations/regions	Share of total world production
Asian NIEs	2,247,594		(86.3)	5.1
Korea	1,068,000	47.5	41.0	2.4
Taiwan	1,059,594	47.1	40.6	2.4
Hong Kong	80,000	3.7	3.1	0.2
Singapore	40,000	1.7	1.6	0.1
ASEAN Nations	355,984		(13.7)	0.7
Thailand	120,000	33.7	4.6	0.2
Malaysia	55,884	15.7	2.2	0.1
Indonesia	60,000	16.9	2.3	0.1
Philippines	120,000	33.7	4.6	0.2
Total	2,603,478			

Sources: APO and JPC casting technology seminars, JICA study team

III-3-2. Production Trends in Leading Countries/Regions

The United States has experienced a major drop in production over the last ten years, with output in the European nations also slumping. Production in Japan has fluctuated, with good figures shown in 1987 and healthy domestic demand helping to boost 1988 production to the highest level ever, thereby breaking the previous record set in 1980.

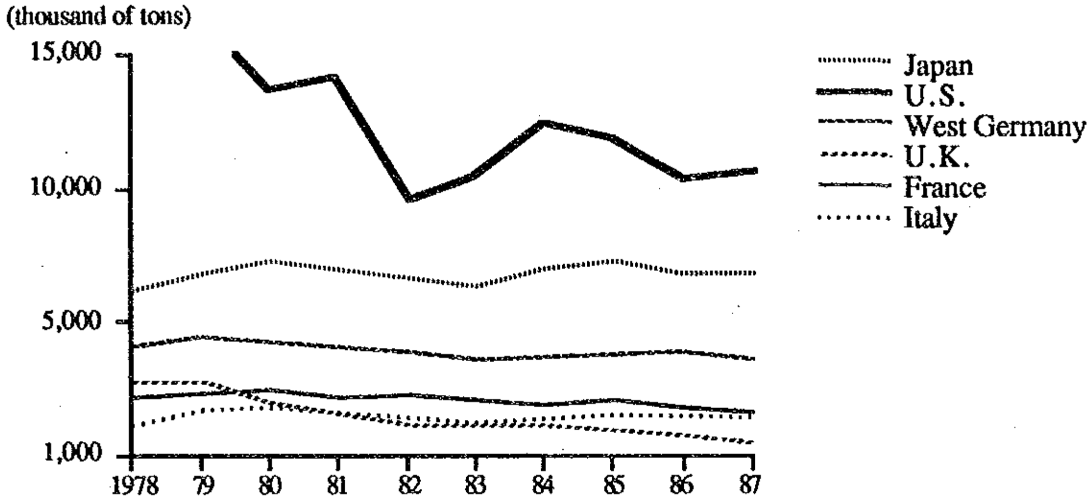
Table III.3-3 Production of Castings in Japan, the U.S. and Europe

(Unit: 1,000 tons)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Japan	6,273	6,968	7,350	6,852	6,510	6,321	6,837	6,987	6,481	6,623
U.S.A.	17,929	17,157	13,705	13,889	9,521	10,321	12,228	11,480	10,057	10,327
West. Germany	4,345	4,646	4,392	4,134	3,931	3,757	3,863	3,999	4,039	3,799
U.K.	3,082	3,050	2,228	1,969	1,787	1,774	1,673	1,553	1,400	1,402
France	2,760	2,814	2,732	2,534	2,492	2,266	2,093	2,138	2,047	2,047
Italy	2,047	2,225	2,242	2,125	1,868	1,733	1,818	1,896	1,888	1,928

Source: Annual December issue of *AFS Modern Casting*

Fig. III.3-2 Production Trends of Castings in Japan, U.S. and Europe



Production in the Asian NIEs of Taiwan and Korea continues to rise but has yet to keep pace with domestic demand. Production by these nations for the last ten years is shown in the following Tables.

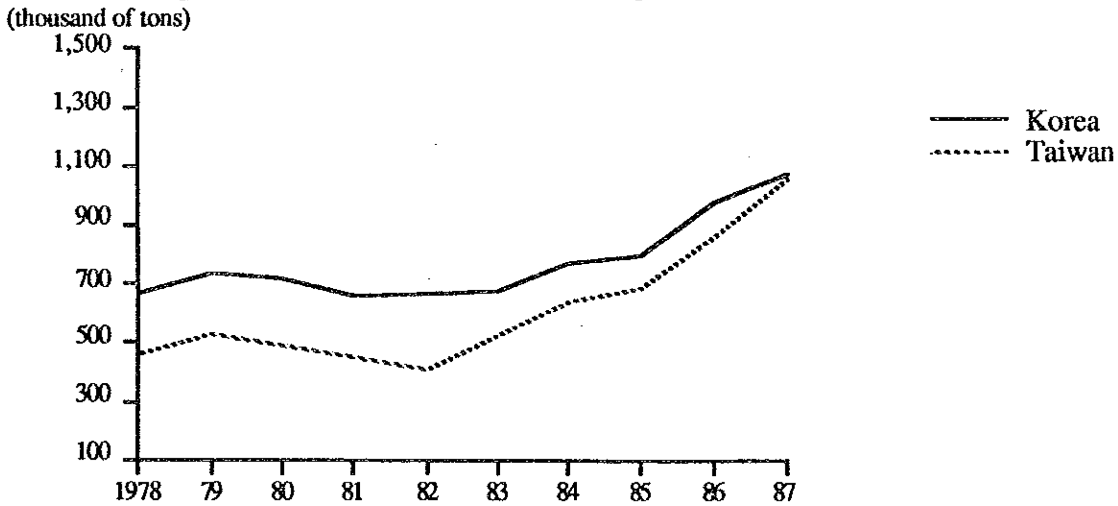
Table III.3-4 Production of Castings in the Asian NIEs and Other Nations

(Unit: 1,000 tons)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Korea	668	716	706	642	654	660	—	797	970	1,068
Taiwan	467	530	506	424	424	524	635	676	879	1,060
Mexico	—	619	939	—	—	—	—	634	434	405
Brazil	1,506	1,640	1,797	1,311	1,311	1,086	1,086	1,530	1,577	1,530

Source: Annual December issue of *AFS Modern Casting*

Fig. III.3-3 Production Trends of Castings in Korea and Taiwan



III-3-3. Current Situation in Leading Countries/Regions

(1) Japan

1988 proved to be a busy year for the casting industry, with production being bolstered by healthy internal demand. An aggressive program of public investment, begun in the previous year as an urgent economic measure, the emergence of the benefits from a strong yen, corporate efforts to gear up for the transition from exports to internal demand, and continued increases in capital investment were the driving forces behind the prosperity of the materials process industries.

The casting industry, which had begun to show signs of recovery in mid-1987, found itself awash in work in 1988. Production volume grew 11.7% over the previous year to 7,391,925 tons.

1) Breakdown of casting production by material

Production of cast iron totaled 4,943,521 tons, a figure closely approaching the record-high figure of 4,956,625 tons recorded in 1973, the year of the Arab oil crisis. Gray cast iron production totaled 3,774,534 tons, an increase of 14.8% over the previous year, and production of ductile cast iron also grew significantly, up 18.1% to 1,168,987 tons. Cast iron pipe was down 6.1%, to 657,736 tons; of this figure, gray cast iron was up 2.5% to 14,210 tons while ductile cast iron fell 6.3% to 643,526 tons. Total production of cast iron, including cast iron pipe, amounted to 5,601,257 tons. Production of malleable cast iron was up 3.0%, to 263,495 tons; steel casting, up 11.7%, to 434,114 tons; copper alloy, up 14.1%, to 106,199 tons; light alloys, up 6.0% to 330,517 tons; die casting, up 11.0% to 647,173 tons; and precision casting, up 16.0% to 9,170 tons. All areas, with the exception of cast iron pipe and malleable cast iron, showed considerable growth.

Table III.3-6 shows casting demand in the main machinery industries.

As can be seen from the Table, in 1988 the transportation equipment industry was responsible for purchasing 2,880,400 tons of cast iron (51.4% of total production), 99,000 tons of malleable cast iron (37.6%), 287,000 tons of light alloy (86.8%), and 497,900 tons of diecast materials (76.9%). Overall, demand in this industry amounted to 3,848,100 tons, or 52.1% of total demand.

Table III.3-5 Breakdown of Japanese Casting Production by Material (1974-88)

(Unit: tons)

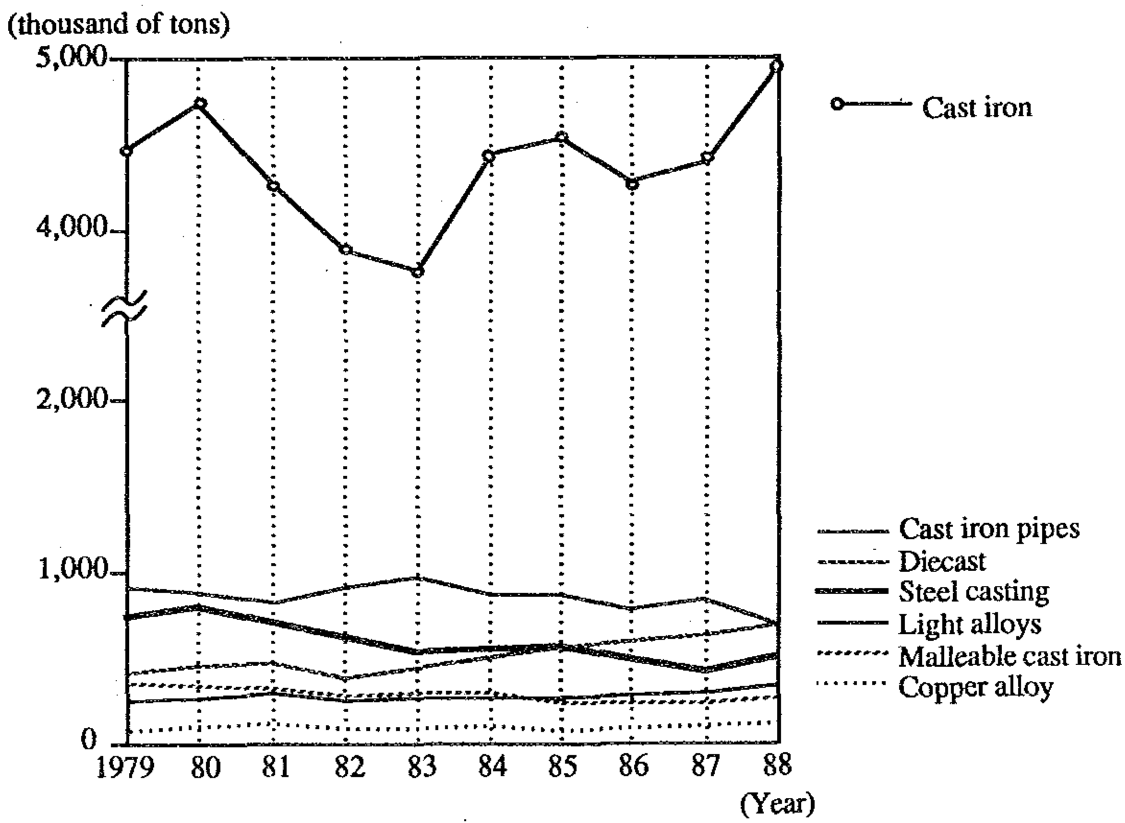
Material		Iron and Steel						Non-ferrous metals				
			Cast iron									
Year	Total	Subtotal	Gray cast iron	Ductile cast iron	Iron and steel pipe	Melleable cast iron	Steel casting	Subtotal	Copper Alloy	Light Alloys	Diecast	Precision casting
1974	7,423,098	6,844,258	4,189,817	493,770	825,346	444,945	890,380	577,077	117,274	172,982	286,821	1,763
1975	5,538,886	5,034,173	3,087,083	404,338	574,673	323,489	644,590	503,521	87,573	163,620	252,328	1,192
1976	5,979,710	5,392,508	3,324,451	460,478	654,936	331,352	621,291	585,475	89,147	192,510	303,818	1,727
1977	6,241,557	5,615,403	3,430,111	510,874	708,708	353,958	611,752	623,900	85,502	206,147	332,251	2,254
1978	6,273,591	5,609,233	3,290,124	585,504	765,503	345,015	623,087	662,096	81,464	229,102	351,531	2,262
1979	6,968,397	6,259,667	3,653,272	716,686	859,107	348,306	682,296	706,044	87,669	243,555	374,820	2,686
1980	7,350,088	6,547,155	3,848,892	788,601	844,808	332,249	732,605	799,335	95,445	269,980	433,910	3,598
1981	6,852,604	6,025,341	3,475,660	771,867	795,858	299,299	682,657	822,769	95,470	277,087	450,212	4,494
1982	6,510,592	5,720,878	3,181,614	744,856	897,287	284,190	612,931	784,796	91,725	264,341	428,730	4,918
1983	6,321,361	5,514,999	3,019,808	784,671	911,583	280,122	518,815	800,238	86,325	268,620	445,293	6,124
1984	6,837,108	5,945,084	3,397,065	887,901	816,188	298,356	545,574	884,336	99,001	285,512	499,823	7,688
1985	6,987,257	6,035,207	3,467,597	938,818	794,946	296,279	537,567	943,310	103,097	289,230	550,983	8,740
1986	6,480,893	5,533,034	3,223,945	938,528	672,443	263,782	434,336	940,072	89,776	289,624	560,672	7,787
1987	6,620,029	5,630,371	3,288,648	990,069	700,335	262,687	388,632	981,796	93,045	311,818	582,959	7,862
1988	7,391,925	6,298,866	3,774,534	1,168,987	657,736	263,495	434,114	1,083,889	106,199	330,517	647,173	9,170

Source: Machinery statistics, Iron and Steel statistical Buletin, Ministry of International Trade and Industry

The next largest source of demand was the general machinery industry, which purchased 1,665,100 tons of cast iron (24.6%), 186,000 tons of steel casting (42.0%), 21,100 tons of copper alloy (19.9%), and 2,000 tons of precision casting (21.7%).

Thus it can be seen that the Japanese casting industry is heavily dependent on the transportation equipment industry.

Fig. III.3-4 Breakdown of Japanese Casting Production by Material (1979-88)



2) Trends in the number of foundries by material

Tables III.3-7 and III.3-8 show trends in the number of foundries by material.

The number of plants in the casting industries in 1988 can be broken down as follows: cast iron, 773, down 14 (1.8%) from the previous year; cast iron pipe, 30, down 1 (3.3%); malleable cast iron, 39, up 1 (2.6%); steel casting, 114, down 5 (4.4%); non-ferrous metals, 398, up 30 (10.5%); die casting, 178. up 6 (3.5%); and precision casting, 34, down 1 (2.9%). Apart from cast iron and steel casting, which have been on a steady downward trend, changes in the number of plants corresponded to demand fluctuations.

Table III.3-6 Casting Demand in Machinery Industry Sectors in Japan

(Unit: thousands of tons)

Demand sector	Material / Year	Cast iron	Malleable cast iron	Steel casting	Copper Alloys	Light Alloys	Diecast	Precision cast	Casting Total
General equipment	1984	1,257.6	18.5	202.4	19.8	23.1	47.4	1.9	1,570.6
		(24.7%)	(6.2%)	(37.1%)	(20.0%)	(8.1%)	(9.5%)	(24.5%)	(23.0%)
	1985	1,258.6	18.1	199.5	21.6	21.9	45.1	2.4	1,567.1
		(24.2%)	(6.1%)	(37.1%)	(21.0%)	(7.6%)	(8.2%)	(27.3%)	(22.4%)
	1986	1,092.2	16.9	172.1	19.7	18.8	41.7	1.9	1,363.2
		(22.6%)	(6.4%)	(39.6%)	(21.9%)	(6.5%)	(7.4%)	(24.6%)	(21.0%)
	1987	1,116.3	12.2	161.5	17.5	19.0	44.1	1.7	1,372.3
		(22.4%)	(4.7%)	(41.6%)	(18.8%)	(6.2%)	(7.6%)	(22.0%)	(20.7%)
	1988	1,378.6	13.2	186.0	21.1	19.3	44.9	2.0	1,665.1
		(24.6%)	(5.0%)	(42.8%)	(19.9%)	(5.8%)	(6.9%)	(21.7%)	(22.5%)
Electrical equipment	1984	139.4	12.5	13.8	4.0	9.7	41.1	0.5	221.0
		(2.7%)	(4.2%)	(2.5%)	(4.0%)	(3.4%)	(8.2%)	(6.6%)	(3.2%)
	1985	132.4	12.4	13.5	4.0	9.1	42.1	0.6	214.0
		(2.5%)	(4.2%)	(2.5%)	(3.9%)	(3.1%)	(7.6%)	(6.6%)	(3.1%)
	1986	111.6	10.3	15.5	3.4	8.4	40.1	0.6	189.9
		(2.3%)	(3.9%)	(3.6%)	(3.8%)	(2.9%)	(7.1%)	(8.1%)	(2.9%)
	1987	114.2	9.8	10.6	3.1	8.4	39.5	0.7	186.3
		(2.3%)	(3.7%)	(2.7%)	(3.4%)	(2.7%)	(6.8%)	(8.3%)	(2.8%)
	1988	139.5	8.0	11.5	3.2	8.6	46.5	0.8	218.1
		(2.5%)	(3.0%)	(2.6%)	(3.0%)	(2.6%)	(7.2%)	(8.7%)	(3.0%)
Transportation equipment	1984	2,300.8	110.5	119.4	18.5	239.4	375.2	2.4	3,166.4
		(45.1%)	(37.0%)	(21.9%)	(18.7%)	(83.9%)	(75.1%)	(31.7%)	(46.3%)
	1985	2,428.1	115.1	104.1	17.8	244.9	426.6	3.0	3,339.7
		(46.7%)	(38.8%)	(19.4%)	(17.3%)	(84.7%)	(77.4%)	(34.6%)	(47.8%)
	1986	2,439.3	104.2	67.8	13.4	249.8	433.8	2.5	3,310.8
		(50.5%)	(39.5%)	(15.6%)	(14.9%)	(86.3%)	(77.4%)	(32.7%)	(51.1%)
	1987	2,557.2	98.6	57.1	11.8	265.5	451.6	2.5	3,444.3
		(51.3%)	(37.5%)	(14.7%)	(12.7%)	(86.8%)	(77.5%)	(32.2%)	(52.0%)
	1988	2,880.4	99.0	69.8	12.0	287.0	497.6	2.3	3,848.1
		(51.4%)	(37.6%)	(16.1%)	(11.3%)	(86.8%)	(76.9%)	(25.0%)	(52.1%)
Other	1984	1,403.4	156.8	209.9	56.7	13.2	36.2	2.9	1,879.1
		(27.5%)	(52.5%)	(38.5%)	(57.3%)	(4.6%)	(7.2%)	(37.2%)	(27.5%)
	1985	1,382.3	150.6	220.5	59.7	13.3	37.2	2.8	1,866.4
		(26.6%)	(50.8%)	(41.0%)	(57.9%)	(4.6%)	(6.8%)	(31.5%)	(26.7%)
	1986	1,191.8	132.4	179.0	53.3	12.7	45.2	2.7	1,617.0
		(24.7%)	(50.2%)	(41.2%)	(59.3%)	(4.4%)	(8.1%)	(34.6%)	(25.0%)
	1987	1,194.7	142.1	159.5	60.6	12.9	47.6	3.0	1,620.4
		(24.0%)	(54.1%)	(41.0%)	(65.1%)	(4.2%)	(8.2%)	(37.4%)	(24.5%)
	1988	1,202.8	143.2	166.9	70.0	15.6	58.2	4.0	1,660.7
		(21.5%)	(54.3%)	(38.4%)	(65.9%)	(4.7%)	(9.0%)	(43.5%)	(22.5%)
Total	1984	5,101.2	298.4	545.6	99.0	285.5	499.8	7.7	6,837.1
		(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)
	1985	5,201.4	296.3	537.6	103.1	289.2	551.0	8.7	6,987.3
		(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)
	1986	4,834.9	263.8	434.3	89.8	289.6	560.7	7.8	6,480.9
		(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)
	1987	4,982.3	262.7	388.6	93.1	305.8	582.9	7.9	6,623.4
		(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)
	1988	5,598.6	263.5	434.1	106.2	330.5	647.2	9.2	7,389.3
		(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)

Source: Machinery statistics, Iron and Steel Statistical Bulletin, Ministry of International Trade and Industry. 1988 figures are compilations of monthly statistics.

Note: "General equipment" includes industrial machinery and equipment, civil engineering and mining equipment, metalworking and metal processing equipment, textile machinery and equipment, agricultural and fishing implements. "Electrical equipment" includes electronic and electrical communications machinery and equipment; "transportation equipment," products for automobiles, industrial vehicles, bicycles, railways, harbors and ships; and "other," equipment for rollers, casting molds and stools, bearing metal, pipe fittings, valve cocks, sundry goods, cast iron pipe, etc.

Table III.3-7 Breakdown of Number of Japanese Foundries by Material (1979-1988)

Material/Year	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Cast iron	1,013	1,003	971	935	866	873	843	806	787	773
Cast iron pipe	25	24	25	25	30	30	30	29	29	30
Malleable cast iron	50	46	41	47	39	39	39	37	38	39
Steel casting	157	152	152	150	141	134	136	129	119	114
Non-ferrous metals	427	415	405	388	363	382	398	356	360	398
Diecast	155	154	152	154	149	179	175	175	172	178
Precision cast	19	19	29	29	29	34	35	35	35	34
Casting (total)	1,846	1,813	1,775	1,728	1,617	1,671	1,656	1,567	1,540	1,566

Notes: (1) Figures for 1979-82 are as of March; those for 1983-88, as of December.
(2) The survey limited itself to foundries having at least the following number of employees: Cast iron, 20; malleable cast iron, 30; copper alloy, 10; light alloy, 20; die casting, 30; precision casting, 30.
(3) Figures for non-ferrous metals were obtained by adding the figures for copper and light alloys.

Fig. III.3-5 Breakdown of Number of Japanese Foundries by Material (1979-88)

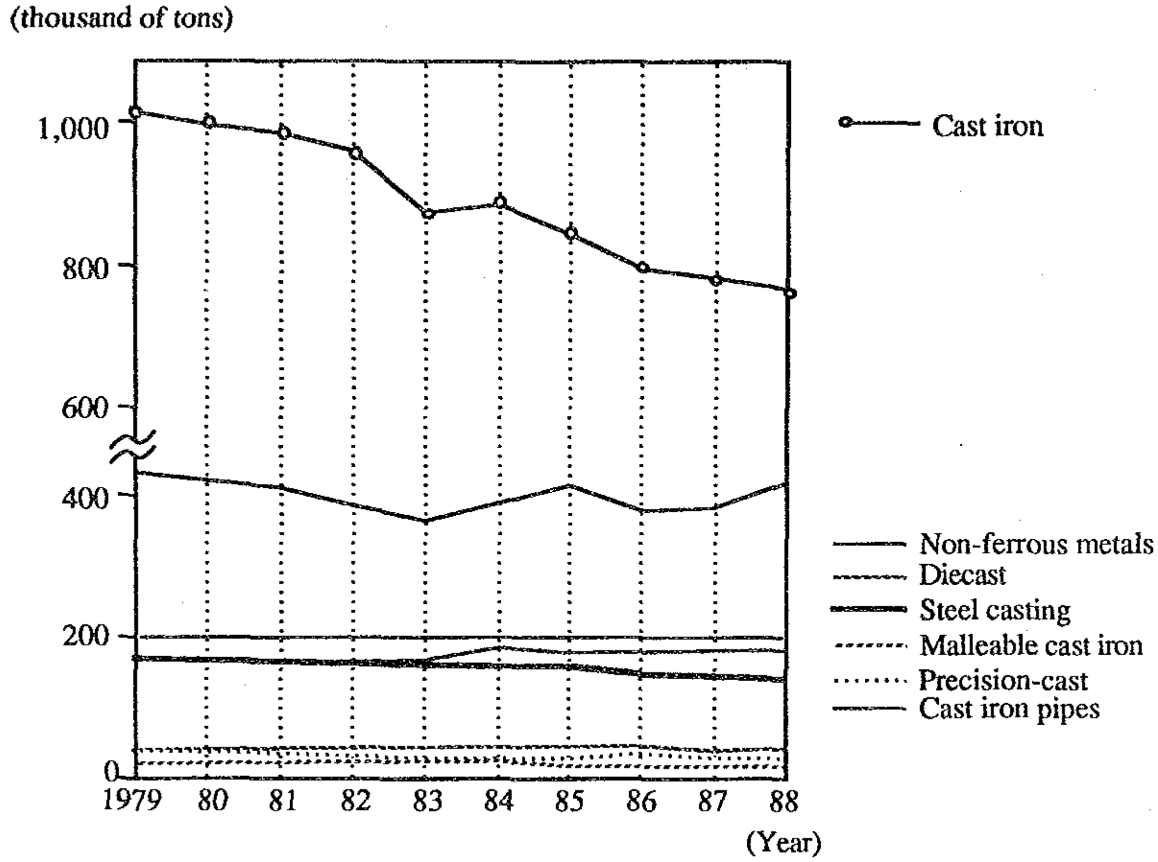


Table III.3-8 shows a breakdown of the number of factories by material and the number of employees (as of the end of December 1988). Plants with fewer than 30 employees were common in the cast iron, copper alloy, light alloy, and precision casting sectors.

Table III.3-8 Breakdown of Number of Japanese Foundries by Size and Material

(December 1988)

Material	Cast iron		Malleable cast iron		Steel casting		Copper alloy		Light alloys		Diecast		Precision-cast	
Number of employees	No. of plants	Percent-age of total	No. of plants	Percent age of total	No. of plants	Percent age of total	No. of plants	Percent age of total	No. of plants	Percent age of total	No. of plants	Percent age of total	No. of plants	Percent age of total
<29	427	55.2	14	35.9	70	59.4	179	81.4	105	59.0	53	29.8	14	41.2
30~49	169	21.9	8	20.5			22	10.0	23	12.9	43	24.1	3	8.8
50~99	103	13.3	7	17.9	30	15.4	12	5.5	24	13.5	44	24.7	11	32.4
100~299	57	7.4	7	17.9	17	14.4	7	3.1	17	9.5	34	19.1	5	14.7
300~499	9	1.2	3	7.8			-	-	8	4.5	2	1.1	1	2.9
500~999	6	0.7	-	-	1	0.8	-	-	1	0.6	1	0.6	-	-
≥1000	2	0.3	-	-				-	-	-	-	1	0.6	-
Total	773	100.0	39	100.0	118	100.0	220	100.0	178	100.0	178	100.0	34	100.0

Note: Figures for precision-cast are for plants using the lost wax technique.

According to Table III.3-9 , the number of cast iron foundries with fewer than 30 employees dropped 6.8% over the previous year to 400. The number of those with 30-49 employees grew 3.2% to 159; those with 50-89, 6.0% to 89; and those with 100-299,

Table III.3-9 Trends in Cast Iron Foundry Size (including Integrated Manufacturers as well as those Specializing in Cast Iron)

Year / No. of employees	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
<29	541	556	529	515	462	450	421	432	429	400
	(53.4)	(55.4)	(54.5)	(55.1)	(57.8)	(56.3)	(54.7)	(58.5)	(59.5)	(56.5)
30~49	233	222	219	210	171	189	192	158	154	159
	(23.0)	(22.1)	(22.6)	(22.5)	(21.4)	(23.7)	(24.9)	(21.4)	(21.4)	(22.5)
50~99	134	130	132	126	109	100	96	90	84	89
	(13.2)	(13.0)	(13.6)	(13.5)	(13.6)	(12.5)	(12.5)	(12.2)	(11.7)	(12.6)
100~299	84	75	71	67	44	46	48	46	43	47
	(8.3)	(7.5)	(7.3)	(7.2)	(5.5)	(5.8)	(6.2)	(6.2)	(6.0)	(6.6)
300~499	9	11	11	9	7	9	7	6	5	5
	(0.9)	(1.1)	(1.1)	(1.0)	(0.9)	(1.1)	(0.9)	(0.8)	(0.7)	(0.7)
500~999	10	7	7	6	4	3	4	5	4	6
	(1.0)	(0.7)	(0.7)	(0.6)	(0.5)	(0.4)	(0.5)	(0.7)	(0.6)	(0.8)
≥1000	2	2	2	2	2	2	2	2	2	2
	(0.2)	(0.2)	(0.2)	(0.2)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)
	1,013	1,003	971	935	799	799	770	739	721	708
	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)
	-	-	-	-	67	74	73	67	66	65
Total	1,013	1,003	971	935	866	873	843	806	787	773

Note: Figures for 1979-82 are as of March; those for 1983-88, as of December.

3) Breakdown of casting industry employees by material

Table III.3-10 and Fig.III.3-6 show breakdowns of the number of employees in the casting industry by material.

3) Breakdown of casting industry employees by material

Table III.3-10 and Fig.III.3-6 show breakdowns of the number of employees in the casting industry by material.

According to Table III.3-10 , the number of casting industry employees in 1988 amounted to 86,821, an increase of 3.7% over the previous year. Virtually all sectors experienced an increase in the number of employees due to healthy demand. The cast iron sector experienced a 2.4% increase, to 40,986; cast iron pipe, a 0.2% increase to 4,329; malleable cast iron, a 7.3% drop to 3,033; steel casting, a 0.4% increase to 6,674; non-ferrous metals, a 9.6% increase to 15,466; die casting, a 5.6% increase to 14,034; and precision casting, a 9.8% increase to 2,299.

Fig. III.3-6 Trends in Number of Employees by Material in Japan (1979-88)

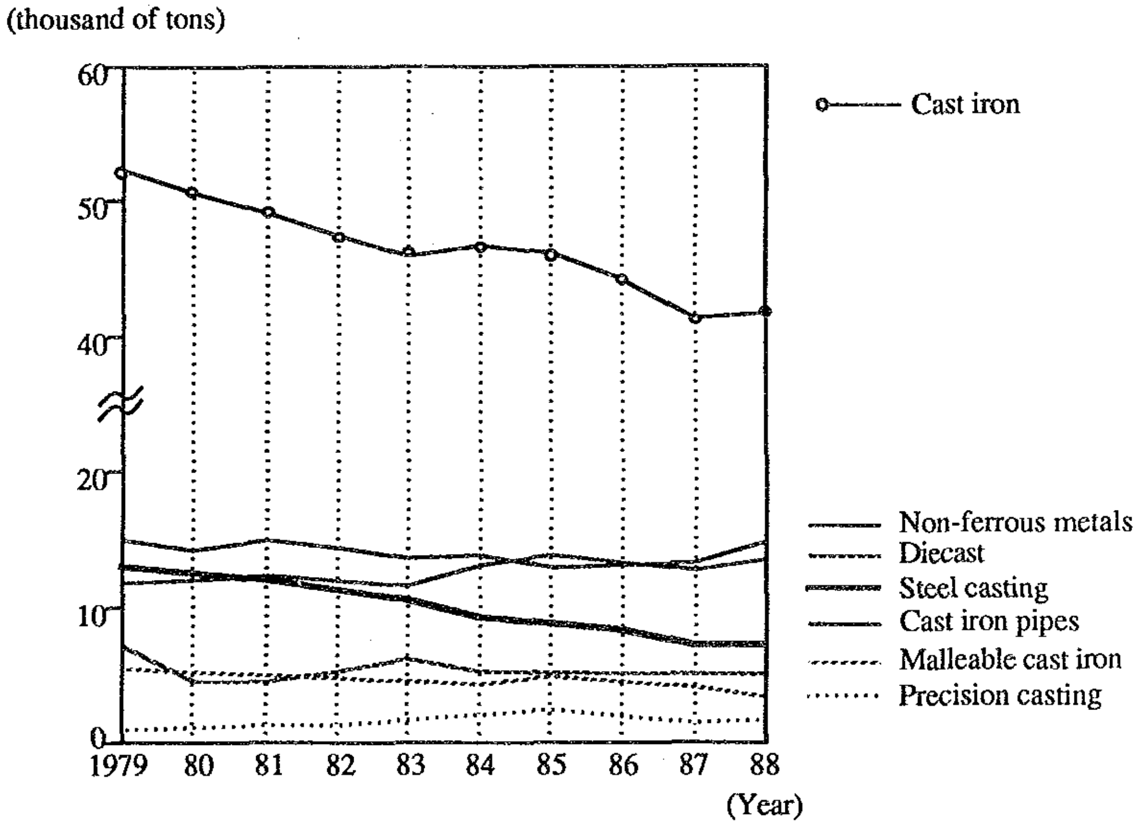


Table III.3-10 Trends in Number of Employees by Material in Japan (1979-88)

Material	Cast iron	Cast iron pipe	Malleable cast iron	Steel casting	Non-ferrous metals	Diecast	Precision-cast	Casting (total)
1979	52,000	6,944	5,592	13,294	14,530	11,763	949	105,072
1980	51,060	4,588	5,081	13,238	15,019	12,107	1,431	102,524
1981	48,910	4,536	4,820	12,779	14,894	12,620	1,487	100,046
1982	46,032	4,852	4,555	12,038	14,178	12,317	1,577	95,549
1983	44,457	5,709	4,225	10,816	13,447	12,042	1,708	92,404
1984	45,209	4,933	4,077	9,693	13,813	13,572	2,031	93,328
1985	44,582	4,591	3,869	9,205	13,745	13,983	2,349	92,594
1986	42,752	4,391	3,497	7,994	13,792	13,774	2,157	88,362
1987	40,027	4,322	3,273	6,649	14,107	13,291	2,093	83,762
1988	40,986	4,329	3,033	6,674	15,466	14,034	2,299	86,821

Source: Annual and monthly Machinery Statistics Bulletin, Ministry of International Trade and Industry. Figures for cast iron pipe were taken from the Iron and Steel Statistics Annual; those for steel casting, from the Japan Cast Steel Association.
Notes: (1) *All figures are as of the end of December.*
(2) Figures for non-ferrous metals were obtained by adding the figures for copper and light alloys. Figures for malleable cast iron, precision-cast, diecast, and powder metallurgy products cover only those operations with at least 10 employees, while those for cast iron opipe and steel casting include operations of any size.

4) Overseas investment by the casting industry

The history of overseas investment by the Japanese casting industry goes back to 1957, when two leading manufacturers of agricultural equipment moved some of their operations to Brazil. At the time, Brazil was engaged in building foundations for various industries, including iron and steel, shipbuilding, agricultural equipment, and textiles, and the two agricultural equipment manufacturers played a role in this process.

In the beginning, most of the cast iron produced by the two firms was destined for the Japanese market, but later it came to be exported to the U.S. and other nations in Central and South America and Africa.

The high economic growth of the 1960s brought on a significant increase in casting production, but the industry entered into a period of low growth in 1973 with the coming of the first oil crisis. Also contributing to this situation were rising wages, difficulties in securing labor, pollution-control measures, and the problem of plant location. It was during this period that overseas investment by Japanese manufacturers took off, much of it being concentrated in Asian nations capable of offering cheap labor. Two leading firms began producing cast iron piston rings in Taiwan in 1968-69, and the two later established plants in Thailand and Indonesia in 1976-77. During the 1970s an increasing number of electrical equipment and electronics manufacturers moved production operations to the NIEs or ASEAN nations. 1973, for example, saw the establishment of plants for the production of household sewing machine components (in Mexico) and household electrical appliance components (in Malaysia). Another firm began producing machine tools in Singapore in 1977.

The following decade saw the emergence of trade frictions, stemming from an increase in Japanese automobile exports in 1980, together with the dramatic appreciation of the yen which followed the Plaza Agreement of September 1985. In response, Japanese manufacturers pursued overseas production in Korea and the U.S. along with overseas procurement of components from the Asian NIEs.

Table III.3-11 and Fig. III.3-7 show foreign investment by Japanese corporations.

Concerning the future outlook for overseas production, cast iron was first examined.

At present, business is booming in the cast iron sector due to plentiful internal demand. Production amounted to 4.94 million tons in 1989 and is expected to exceed the 5-million-ton mark in 1990. On the price front, however, few firms have yet to achieve a return to before appreciation of the yen, and as a result profitability has yet to achieve sufficient levels. Particularly at plants using hand molding for machine tool cast iron, it remains difficult to hire qualified personnel, and the average age of employees is on the rise. These factors have led to increasing fears among buyers concerning the long-term stability of cast iron supply.

As a result, recent overseas cast iron supply plans have tended away from temporary arrangements pursued simply for the sake of cost reductions and towards production operations designed to provide a stable supply over the long term. This is particularly true in the case of cast iron for machine tools, with Thailand, and in the future China, seen as promising candidates to replace the Asian NIEs as suppliers.

In the case of cast iron for use in auto parts, the needs of Japanese-affiliate automakers to increase local content and the demands of the Big Three and other local customers suggest that overseas production is likely to increase steadily in the mid-term.

The maintenance of Japan's technological superiority against this backdrop will require increased efforts in the areas of new product and production technology development. It has also been pointed out frequently that factories within Japan will take on increasing importance as "mother plants" for overseas production bases.

At present, the cast iron sector is experiencing healthy demand, but the internationalization of Japan's economy is expected to bring numerous problems in the future. However, the quality, cost, and delivery time management technologies cultivated in this sector along with pollution-control technologies and management know-how are of the highest standards in the world. In the future, this sector will be expected to make contributions to the rest of the world using this technology and know-how.

In recent years, manufacturers using the lost wax technique have received numerous requests for technical guidance from firms in Korea and Taiwan.

The NIEs have also hatched out strong promotion policies for their automobile industries, and Japanese automakers investing in these countries will tend to move away from knockdown production and towards integrated assembly and production. Concrete plans are in the works for local production of key components such as engines, transmissions, and suspensions, and in some countries this type of production is already under way.

If the demand for precision castings, and engine components in particular, increases in the automotive industries of the NIEs, it is possible that cooperative agreements with Japanese manufacturers will develop into joint ventures and that excesss local production capacity will be exported to Japan. Lost wax and other precision casting techniques require advanced production technologies, however, and it is unlikely that large-scale overseas supply will become a problem (quantitatively) in the near future.

Table III.3-11 Breakdown of Overseas Production Operations of Japanese Companies

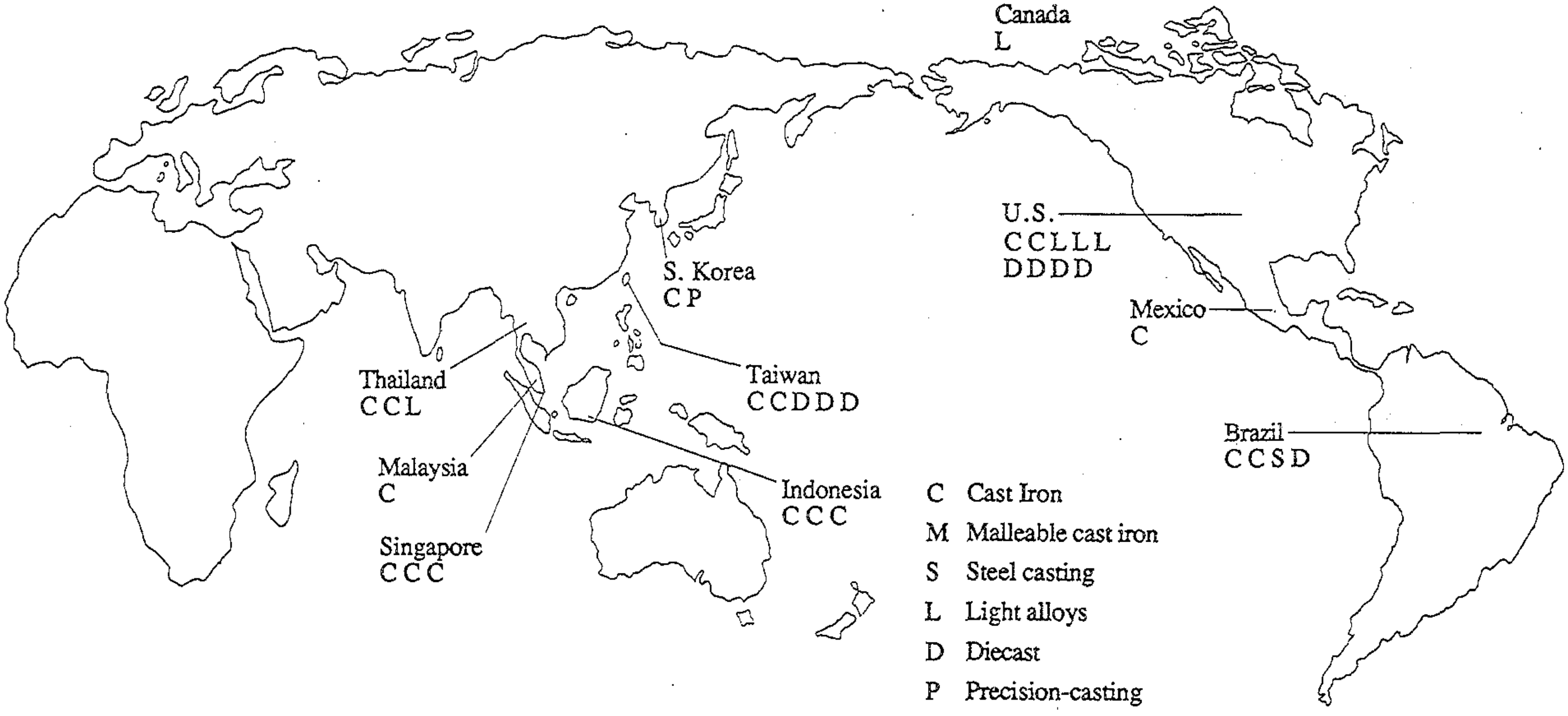
Production items	U.S.	Canada	Mexico	Brazil	Korea	Number of operations Taiwan	Singapore	Thailand	Malaysia	Indonesia	Total	Product totals (including repetitions)
Cast iron	2		1	2	1	2	1	2	1	3	15	15
Malleable cast iron												
steel casting				1							1	1
copper alloy												-
Light alloys	3	1						1			5	13
Diecast	4			1		3	1				9	9
Precision-cast					1		1				2	2
Subtotal	9	1	1	4	2	5	3	3	1	3	32	40
Casting				1		1					2	4
Metal pressed	6					2		1	1	1	11	14
components												
Powder metallurgy	3				1		1				5	5
Subtotal	9			1	1	3	1	1	1	1	18	23
Total	18	1	1	5	3	8	4	4	2	4	50	63

Notes: (1) "Number of operations" figures represent only those firms for which the given item is the main production item.
(2) "Product total" figures indicate the total number of firms engaged in production of the given item, regardless of quantity. Hence the average number of production items per operation was 63/50 = 1.26.

Table III.3-12 Breakdown of Overseas Production Operations by Country/Region and Year in which Operation was Begun

Country/ region	Year ~70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	Total
U.S.												1		1		1	1	2	6	6		18
Canada																1						1
Mexico				1																		1
Brazil	2					1		1					1									5
Korea											1							1	1			3
Taiwan	2		1							2	1			1					1			8
Singapore								1		2						1						4
Thailand				1			1				1									1		4
Malaysia				1														1				2
Indonesia			1		1		1	1														4
Total	4	0	2	3	1	1	2	3	0	4	3	1	1	2	0	3	1	4	8	7	0	50

Fig. III. 3-7 Overseas Production of Japanese Companies



Note: The figure does not necessarily cover all Japanese affiliates in foreign countries. In the case of Malaysia, manufacturers of malleable cast iron are not included.

Source: Survey report on demand trends, the Materials Process Technology Center

5) Foundry parks in Japan

Japan has foundry parks at six locations, including Ehime, Okayama, and Yamagata prefectures as well as Tokyo, but fewer than 100 companies, not a significant portion of the industry, have relocated operations to these parks. This section will introduce the Ehime Pig Iron Casting Park, which possesses comparatively large-scale common facilities and has been quite successful.

a) Outline

This park was established in 1972, a time when pollution was a major social problem, and even today pollution prevention efforts remain near the top of the park's agenda.

[1] Summary

Name: Ehime Gray Cast Iron Park Cooperative Association

Location: Ehime prefecture, Japan

Date of establishment: July 1972

Investment: ¥42.2 million

Association member firms: 11

[2] Park area

Plants:	64,491 m^2
Association:	10,381 m^2
Roads:	9,702 m^2
Greenery:	3,840 m^2
Other:	630 m2
Total:	89,044 m^2

[3] Common facilities

Facility	Capacity	Quantity
High voltage receiving facility	6,600 kw x 12,500 kwa	1
Compressor facility	300 hp	5
Common water supply station	1.5 m^3/min	3
Testing facility	Mechanical testing, elemental analysis, sand analysis, etc.	1
Joint wastewater treatment tank		1
Truck scale	40 tons	1
Material warehouse	550 m^2	
Firefighting equipment		1

[4] Testing facility

Vacuum atomic emission spectrometer (Quanto meter)

Ventilation meter

Bend compressive strength sand tester

Moulding sand grain size measurement device

Universal sand strength testing machine

Electronic moisture meter

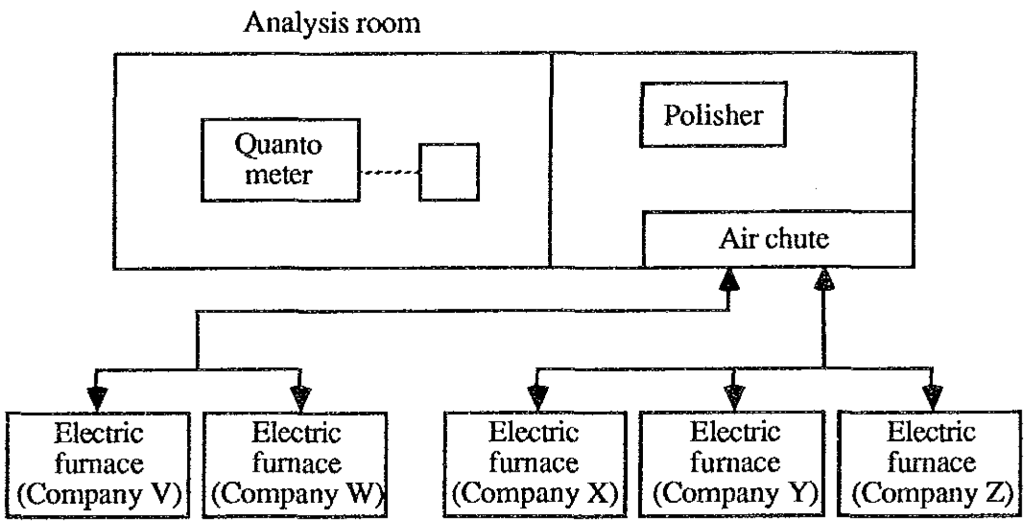
Brinell hardness tester

Compactability controller

Sand tester

Moulding sand automatic moisture tester

The cant recorder is linked to the melting facilities at various companies by air chutes and performs elemental analysis of the molten metal. Results can be obtained from a plant located 500 meters away in only 50 seconds.



(d) Pollution prevention facility

Dust tube collector TDC-40S

Back filter cross back Model 120

Plate filter 4K-4W

Dust collector

b) Operation

In principle, association members do not pay any fees, and money earned by the association is used for park management and for repayment of loans taken out for the purchase of land and facilities. The reason for the absence of membership fees is that whether the fees were uniform for all companies or else determined based on land area or the number of employees they would create dissention among tenant companies.

[1] Plant sites

When plant sites are purchased by tenant companies, half of the value is paid in cash, with the remaining half borrowed from the government at low interest and repaid through the association in monthly installments over 15 years.

[2] Association land (including roads and greenery)

Purchased by the association using long-term financing. Monthly payments are made from association earnings.

[3] Buildings

All design and construction work is entrusted to the same two architectural and construction firms in order to avoid mismatches in plant height and color.

[4] Facilities

Facilities are also purchased with long-term loans. Necessary facilities are decided upon at board meetings, which are held at least once a month.

[5] Earnings

Earnings come in the form of utility payments (electricity, water, and air, which is used in molding) and testing and inspection fees paid by tenant companies as well as storage fees earned by lending out storage space to outside companies. Electrical power, purchased in bulk by the association, is relatively inexpensive, and the difference between the amount paid and the amount received from tenant companies is kept by the association. Testing and inspection fees are kept lower than those at public facilities in order to encourage frequent use. Companies are not allowed to possess more than one day's inventory (with the single exception of steel, for which a three-day's stock is permitted).

[6] Operating costs

Personnel costs for the park director and five other personnel are paid out from association earnings. Miscellaneous expenses are taken from the nominal membership fees, which consist of a fixed fee plus an amount based on the plant area.

Note: Loans have been nearly repaid, reducing the need for large earnings. As a result of the current business boom, however, the association is now considering increasing earnings for the future.

c) Common facilities

Common testing facilities are being effectively used since they are too costly for small and medium-sized firms to purchase on their own. Comments made during the interviews concerning the above-described facilities as well as equipment which has yet to be purchased by the park are summarized below.

[1] Compressors

Breakdowns and other types of trouble are frequent and can force production shutdowns for long periods of time. In order to avoid this, common compressors have been introduced and are used to send air to each plant via piping. However, the decision of whether to make these facilities common or individual depends on the size of the park and tenant plants.

[2] Wastewater treatment

Performed jointly. This decision was made independently by the park and is not regulated in the governmental ordinances.

[3] Heat treatment

Performed by just one company. The others rely on outside contractors.

[4] Shot blasting machines

Available at all of the companies.

[5] Electroplating

Outside contractors used when necessary.

[6] Wooden patern, mould and die workshop

Each company has its own outside contractor.

[7] Multi-purpose facilities

Exhibition hall: No need for an exhibition hall on this park grounds.

Resource centre: Although there is no information centre, the association does collection and distribute information for tenant firms.

Lecture rooms: There are no dedicated facilities, but technical lectures are held in a conference room two to four times a year.

CAD/CAM facilities: Not available. Computers are used only for production management and accounting.

R&D facilities: No joint facilities.

Joint purchasing and the shared taking of orders are not carried out at present, although indirect assistance, such as customer inquiries and information distribution, is provided by the association.

Delivery is also performed separately by each company, with no direct supervision by park officials.

d) Characteristics of the Ehime Cast Iron Park

Following is a list of the main characteristics which distinguish the Ehime park and have contributed to its development.

-Low-interest government loans are used for the purchase of park land and facilities.

-When companies purchase land in the park, half of the amount is paid in cash. For small businesses, this initial burden serves to increase the sense of responsibility and will to succeed.

-Expensive testing equipment is purchased as common facilities using low-interest government loans and can be utilized at low cost by tenant companies.

-Membership fees are nominal, and most of the park operating expenses can be covered by a portion of the fees paid by companies for utilities and use of the testing facilities.

-The park is favorably located only a short distance from the harbor.

-They are provides a relatively stable hiring environment.

-In principle, there is no raw material inventory.

-Companies frequently exchange information and hold meetings.

-Advanced technology is the focus of information collection and information centre activities through seminars.

-Pollution-related problems are dealt with aggressively on the initiative of the park.

Table III.3-13 Summary of Tenant Plants

Company	Capital (¥1,000)	No. of employees	Total area (Building area) (m^2)	Main products	Production capacity (tons)
A	5,000	18	3,464 (1,420)	Large crane components, industrial equipment components, large press components	150
B	50,000	47	10,567 (2,424)	Components for agricultural implements, universal engines, automobiles and industrial equipment	500
C	90,000	91		Components for industrial equipment, construction equipment , and electrical equipment	
		Headquarters	22,772 (4,260)		500
		Nagoya branch	17,156 (5,641)		500
D	10,000	7	3,530 (750)	Mold finishing using grinders	
E	30,000	36	4,000 (1,800)	Waterworks components, industrial equipment components, hydraulic components, manholes	400
F	3,000	21	3,296 (1,326)	Cast iron pipes for waterworks, industrial equipment components	150
G	20,000	28	7,046 (2,100)	Components for automobiles and construction equipment, special water pipes, parts for agricultural implements, hydraulic equipment, and industrial equipment	250
H	30,000	12	5,332 (1,307)	Components for agricultural implements, construction equipment, and automobiles	250
I	5,000	5	1,250 (1,080)	Components for machine tools and agricultural implements (specializing in small parts under 10 kg)	30
J		10	3,538 (707)	Shell cores for use in casting	150
K	45,000	32	5,703 (1,920)	Design and fabrication of metal moulds and moulding machines, machining	

Source: Ehime Cast Iron Park

(2) U.S.

Table III.3-14 shows U.S. production of castings for the ten-year period 1978-87. Total production volume dropped significantly, from 17,929,616 tons in 1978 to 13,705,983 tons in 1980 (down 23.6%) and 9,521,396 tons in 1982 (down 46.9% from 1978). In 1983 production returned to the 10-million-ton mark and rose to 12,228,497 tons (down 31.8% from 1978) in the following year. Growth became sluggish after 1983, however, and production remained at 10,327,453 tons (down 43.4% from 1978) in 1987. When broken down by material, production of gray cast iron fell from 11,415,062 tons in 1978 to 8,372,286 tons in 1980 (a decrease of 26.7%), further dropping to 5,799,483 tons (down 49.2% over 1978) in 1982.

Although there was a slight recovery in 1984 to 7,293,376 tons (down 36.1% from 1978), production again took a turn for the worse, falling to 5,159,248 tons (down 54.8% from 1978) in 1987. Production of ductile cast iron fell from 2,606,125 tons in 1978 to 1,633,207 tons (down 37.3%) in 1982. This was followed by a gradual recovery, however, and by 1987 production had finally returned to the levels of ten years before (2,648,117 tons, up 1.6% over 1978). Production of malleable cast iron had long remained above the 700,000 ton mark and amounted to 739,740 tons in 1978. This was followed by annual drops until production volume hit 258,268 tons (down 65.7% from 1978) in 1982. Although there was a recovery to 469,739 tons (down 36.5% from 1978) in 1986, this was followed by a major reduction to 288,490 tons (down 61.0% from 1978) the next year. Steel casting production in 1978 totaled 1,689,552 tons, but this figure had dropped 60.9% to 662,291 tons by 1983.

Production recovered to 868,338 tons (down 48.6% from 1978) in 1984 but showed no significant growth thereafter, with 1987 production amounting to 752,976 tons (down 55.4% from 1978). Copper alloy production grew from 257,581 tons in 1978 to 268,722 tons in the following year, dropping to 183,591 tons (down 28.3% from 1978) in 1982 but then recovering to 283,652 tons (up 10.1% from 1978) by 1984. This was followed by annual reductions, with production falling to 216,237 tons (down 16.1% from 1978) by 1987. Aluminum production, amounting to 911,356 tons in 1978, fell 65% to 592,512 tons in 1982, but later recovered to 1,010,808 tons (up 10.9% from 1978) in 1985. 1987 production remained steady at 1,012,501 tons (up 11.1% from 1978).

1987 U.S. demand for cast iron can be broken down as follows: automotive, 44%; machinery, 22%; valves and pipe fittings, 7%; and miscellaneous, 27%. The same figures for steel casting are: railway equipment, 34%; machinery, 16%; valves and pipe fittings, 3%; automotive, 2%; and miscellaneous, 45%.