Class C: a) These companies produce aluminium plate using very old-fashioned pull over rolling systems and may be roughly divided into two groups: ones which work this plate into utensils and ones which obtain supplies of aluminium plate from domestic rolling companies and produce utensils using small size facilities. The companies belonging to this class are located only in Medan, Kalimantan, and other sales regions and are engaged in small scale production.

Photo 3-3-11: Production of Household Utensils with Outdated Facilities

(Most of the production facilities are old and not equipped with safety apparatus)

(Female workers work in sandals and skirts which are regarded as unsuitable for factory work)

(b) Aluminium plate roofing

Since this is simple work using a single machine for the roll forming process, there are almost no problems with the technical level. The quality of the final product is determined by the precision of thickness and flatness of the aluminium coil material. When the material is poor in quality, the forming itself becomes impossible.

In Indonesia, a single company monopolizes the production and supply of aluminium coil material for making aluminium plate roofing and is not making sufficient effort to improve quality. Complaints are voiced over shipments of plates with different thicknesses at the two ends without sufficient inspection being made. In this way, the quality standard at the present is a quality enabling use in some way or another.

(c) Aluminium foil

Only one company is producing aluminium foil in Indonesia. This company is producing foil using eight used foil rolling mills. The company monopolizes the field for foil of thicknesses of down to 7 microns. Domestic demand is not growing much at the present and there is tariff protection and a large requisite initial investment, so for the time being it is not believed that any new companies will enter the field. It would be technically difficult to roll foil of less than 7 microns thickness with the present facilities of the company.

Demand for aluminium foil in Indonesia is estimated to be about 900 tons or so a month. Of this, about half, 450 tons, is believed to be supplied by this company. The remaining foil is foil of a thickness of less than 7 microns or foil laminates with paper or vinyl. These require advanced technology for manufacture and so Indonesia substantially relies on imports for the entire supply.

In general, the problem in rolling foil is the tearing of the material due to the small rolled thickness. How is prevent this is a major technical issue. The main reasons for tearing are (1) distortions in the shape of the plate and (2) defects in the materials. The general solutions for the problem (1) used in the advanced nations are cleaning of the melt at the time of casting, elimination of roller scratches and slitter defects at the time of rolling, and cleaning throughout the manufacturing process to prevent entry of foreign matter.

The company is producing aluminium foil by rolling foil plate rolled from slabs in-house, but uses old-fashioned machinery and equipment throughout and is not sufficiently cleaning the melt or eliminate shape distortions during rolling. This has a large impact on the yield of the final product aluminium foil. The company is, however, renovating its machinery and equipment at the present time and around when it begins operation of the newly introduced cold rolling mills with AFC units and due also to new melting and casting facilities, it should vastly improve its product yield.

(d) Aluminium impact tubes and cans

The production lines, production volumes, facilities owned, and materials used by the five major aluminium impact tube and can manufacturers of Indonesia are summarized below:

	Production line	Production volume (month)	Machines owned	Materials
Company A	Aluminium cans	150 MT	West German (4)	Aluminium ingots
Company B	Aluminium tubes	30 MT	West German (4)	Aluminium ingots
Company C	Aluminium tubes	20 MT	West German	Imported slugs
Company D	Aluminium tubes	10 MT	West German (4)	Domestic slugs
Company E	Aluminium cans	15 MT	West German (2)	Imported slugs
Total		225 MT/month		

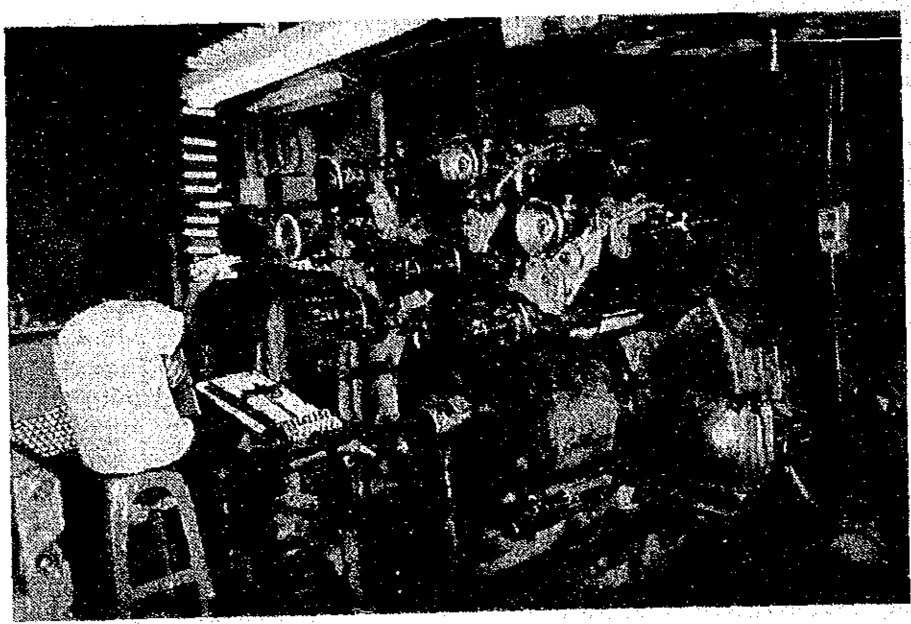
Source: Current field survey.

As mentioned above, company A boasts the largest production volume domestically by an overwhelming degree. The company engages in integrated production, performing everything from the melting of new aluminium ingots to the manufacture of the final products. Further, it sells slugs outside as well. However, it does not analyze the components for all melted lots and it is unclear if the purity of the intermediate slugs is maintained at the minimum 99.7 percent.

The manufacturing facilities of company A are used machines of West German make. The production technology is also being introduced from West Germany. The shape and printing of the final products are inferior overall, but due in part to these being bulk products, there is little competition with imports and they are accepted by domestic users.

Manufacturers other than company A use inferior quality materials and use antiquated machinery and equipment, so their productivity is low and the quality of the final products is not good. In particular, the slug materials are not stable, so the shapes of the final product tubes and cans are not stable, which causes problems in the printing stage. Even during the visit of the survey team, several lines were observed when stopped operation due to breakdowns of the machinery. Due to the low labor costs, several workers are positioned around a single machine and the human wave tactic used to deal with such trouble.

Photo 3-3-12: Production of Aluminium Impact Tubes



(Production is done with outdated facilities and this results in various quality problems)

(Because one machine is operated by five to six workers, productivity is low)

[3] Product development

(a) Aluminium household utensils

There has been remarkable recent growth in household utensils in Indonesia, with growth of about 10 percent a year displayed in the past two years. On the other hand, the national income has been rising steadily, so demand for high class utensils of a higher added value should grow steadily.

The manufacturers of class A have been working on exports of high class items such as items with Teflon coatings or anodizing treatment despite the somewhat poor profit margins. In the future, they should be able to sufficiently handle pressed products such as high class utensils with their current facilities and if they are supplied with high quality aluminium plate materials should be able to increase exports through OEM production or parts supply.

On the other hand, the class B and C companies are judged as not having much leeway for tackling product development in view of their current facilities and technical capabilities.

(b) Aluminium plate roofing

As mentioned earlier, aluminium plate roofing has increased in demand, winning over competing items such as color steel plate or slate, by making use of the features of the aluminium. In the roll forming field, development of new products such as siding, a future wall material, or storm doors or other building materials could be expected, but there are virtually no companies which are engaged in full-scale product development. It is considered necessary to eliminate the current domestic situation where single companies monopolize the supply and to at least allow competition with overseas products so as to provide motivation for development of products of a higher added value and better quality.

(c) Aluminium foil

In the future, it is considered that there will be growth in demand for higher added value thin foil, lamination use foil, and foil products. The single company in Indonesia now producing foil is proceeding with improvements in the quality of its foil and has reached the point where it has the technology for making foil of less than 7 microns thickness. The development of thin foil with sufficient flatness would enable production of laminates with paper and vinyl.

The company is also already working on the production of foil trays, gas stove mats, and other foil products and therefore should be able to increase its exports of such products, where price is stressed the most, to Japan and the Southeast Asian countries.

(d) Aluminium impact tubes and cans

In Japan and the western advanced nations, aluminium tubes for toothpaste are being changed over to plastic laminates, while aluminium aerosol cans are being replaced with tinplated cans, so the growth of demand for aluminium tubes and cans is slowing down. Growing in their place are such fields as condenser cases, copy drums, and other electrical and electronic components. In the future, should the Indonesian electrical and electronic related industries develop, demand in these fields should soar. Further, the production of impact tubes itself is a kind of cold forging of aluminium and improvements of the forging technology should bring out tremendous potential demand in fields such as auto parts and components for high priced products.

The most important element determining quality of such sophisticated processed items is the quality of the slug material. Just how to improve the quality of the slugs being supplied domestically at the present time will be the most important factor in international competitiveness in these fields in the future.

[4] Production management and quality control

A look at the state of control in household utensils, a leading Indonesian aluminium plate worked product, shows the same features as seen for rolled products, that is, (1) production of limited products, (2) anticipatory production, and (3) small numbers of supervisors and large numbers of simple workers. These are the features of this industrial field. Production costs are low, and a limited number of products, such as considerably inferior quality pots and kettles, are produced in large quantities.

A look at the production management shows that large numbers of machines suited to mass production of limited items and simple work, such as full draw presses, deep draw presses, and surface buffing machines are installed and work is being performed by manual labor. If not concerned with the quality, then it would be judged that productivity was good and that control was being exercised to keep costs low. In the future, however, to give the Indonesian aluminium industry international competitiveness, it will be necessary to i) introduce the latest machinery and equipment, ii) introduce modern management, iii) pursue higher productivity, and iv) establish a sufficient R&D function.

[5] State of Factories

The state of the production areas at the aluminium plate work manufacturers was surveyed based on a "factory check list". The survey was conducted on seven household utensil companies and two impact tube companies. Roofing companies and the foil company were not included here because they are all rolling companies and the state of their production areas were mentioned earlier. A summary of the results of the survey is given in Table 3-3-51.

The seven household utensil companies surveyed vary in production volume as well as size and level of production facilities. One company, which produces high value-added products using foreign advanced technology, was awarded 2 points or 3 points on most of the evaluation items. In contrast with that company, three companies which produce cheap and low-value-added products were awarded 2 points on about one third of the evaluation items in the areas of production and technology and labor management and 1 point on the rest. The remaining three companies fell somewhere between these two examples.

Items which were highly evaluated for all seven of the household utensil companies were dispatched workers, speed of operation, working speed and operation efficiency under work management, and factory layout under plant management. Low scores were common on four items under product management, four items under quality control, three items under work management, two items under safety and sanitation and one item under morale. It may be said that all of the companies put emphasis on how efficiently they produce products rather than on how comfortably and safely their employees work. In addition, less attention is paid to the quality of the products, with the exception of those products to be shipped abroad.

Impact tube companies have, in general, good plant management. Factory layout is especially good and highly efficient production facilities are used. Job arrangement at the impact tube companies is done properly so that the employees can work effectively. On the other hand, in the area of production and technology, sufficient quality control is not performed. Manufacturers are equipped with simple inspection apparatus which is not adequate for inspection of high-value-added products. The other problem area under the category of working environment is in the area of labor management. Specifically, employee welfare activities such as the supply of uniforms or establishment of an employee lounge are expected.

Table 3-3-51: Results of the Field Survey at Factories (Household Utensils; Impact Tubes)

Evaluation Item	Check Points	Average Points: Household utensils	Average Points: Impact tubes
Production and technology			
Work management			
1. Dispatched workers	• Level of automation, Job range	2	2.5
2. Speed of operation	• Earnest attitude, A look in eyes, A chat during work (talking during work?)	1.9	2
3. Working speed	• Speed of manual work, Working speed	2	1.5
4. Operation efficiency	• Frequency of operation stoppage, The number of workers walking about, Meetings	2	1.5
5. Management style	• Posting of notices regarding production targets and achievements, posting of notices regarding attendance	1.1	1.5
6. Operation improvement	• The amount of wastefulness, Improvements in jigs and fixtures	1.7	2
Product management			
7. Materials, parts	• Containers, Storage methods, Manner of piling, Use of shelf labels	1.6	2
8. Semi-processed products	• The degree of accumulation, Use of stock slips	1.6	1.5
9. Finished products	• Types of packing, Cleanness of packages	1.6	2
10. Material handling	• Notice of storage space, Transportation method, Manner of placing	1.4	2
Quality control			
11. Process inspection	• Posting of notices regarding inspection standards, The level of inspection skill, Boundary samples	1.4	1
12. Handling of defective products	• Notices regarding defective units, Classification of storage spaces	1.7	1.5
13. Inspection equipment	• Manner of handling, Inspection marks	1.3	1
14. Management method	• Control charts, Posting of notices of defect and other ratios	1.3	1
Plant management			
15. Factory layout	• The level of adopting assembly line, The level of continuous operation	1.9	2.5
16. Maintenance of equipment	• Soil on equipment, Proper pipe laying and wiring	1.6	2
17. Maintenance of building	• Uneven floor, Broken windows, Coloring, Rain-cover, Roof leakage	1.7	2
Labor management			
Working environment			
18. Proper arrangement	• Establishment and indication of aisles, Manner of placing jigs and fixtures	1.6	2
19. Clothing	• Uniform and regulation cap, Work shoes, Name tag	1.1	1
20. Lighting	• Lighting levels, Lighting method	1.7	2
21. Ventilation	• Dust, Foul odors, Windows, Ventilating fans	1.1	1.5
22. Rest area	• Existence of space for a rest area	1.6	1
Safety & sanitation			
23. Safety	• Posting of danger signs, Use of safety equipment, Posters promoting safety in operations	1.3	1
24. Sanitation	• Cleaning of building and aisles, existence of a sashhand stand	1.4	1.5
Morale			
25. Motivation	• Existence of a bulletin board, Existence of a quality control bulletin board, Posting of a company slogan	1.1	1

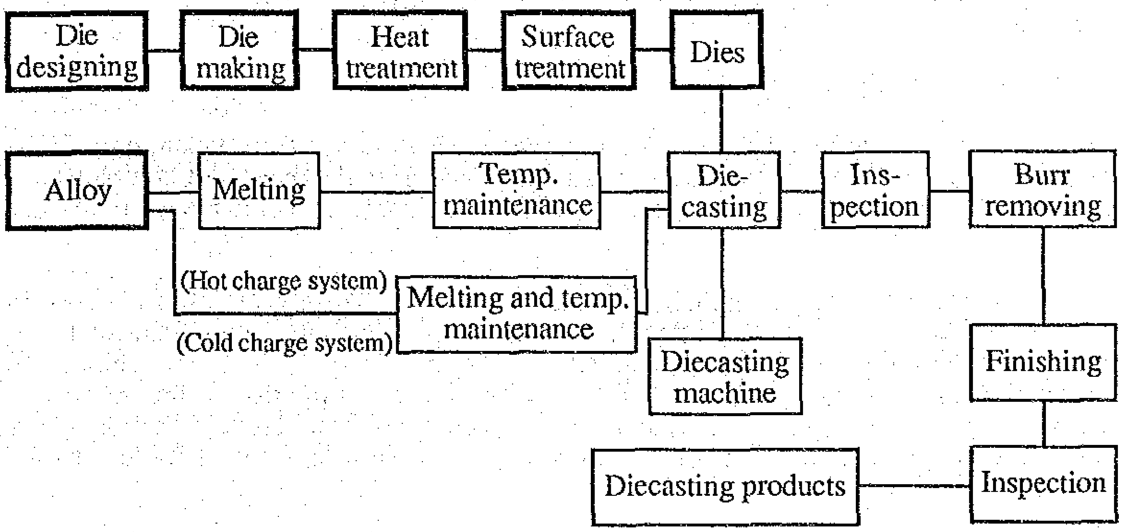
Source: Factory survey

4) Die-casting

[1] Manufacturing process

The flow of production of aluminium diecasting is illustrated as follows:

Fig. 3-3-24: Flow of Diecasting Production



In general, industrial products are said to be produced by the 5M elements, that is, materials, machines, methods, men, and money. In die-casting, in addition to these 5M's, the dies are key production elements. That is, die-cast products are produced by the 5M + 1D.

Once receipt of an order from a customer has been determined, a grasp is obtained of the points of quality of the product and a die is fabricated designed to satisfy the same. The die-cast product is made by these dies, the aluminium alloy material, the die-cast machines (including attached apparatuses), plus men, work methods, and money, i.e., the 5M + 1D.

The die-cast manufacturing processes may be roughly divided into the hot charge system and the cold charge system. The difference between the two lies in the melting process of the alloy and the heat retention process. In die-casting, the basic temperature control is an important control item and has a major impact on the quality of the final product. The hot charge system features easier temperature control of the melt compared with the cold charge system, so the hot charge system is desirable for production of high quality die-cast products.

In the manufacturing process, the alloy and dies are considered to be the main problem areas at Indonesian domestic companies.

The alloy locally melted and refined is shipped out without sufficient inspection, so the composition is uncertain and the reliability poor. Further, the domestic supply is insufficient compared with the demand. On the other hand, the technology for designing dies is underdeveloped and there is no knowhow, so complicated die designs and manufacture are not possible. Further, suitable heat treatment and surface treatment are not possible. Therefore, various troubles occur with the dies, the lifetime of use is short, etc.

[2] Technical level

The technical level was observed to be vastly different between foreign affiliates and local companies. The foreign affiliates, in the majority of the cases, were transport machine related assembly manufacturers which were producing the parts for internal use in-house. On the other hand, there was only one local company, without the exception of manufacturers making very small quantities of parts in-house, specializing in die-casting. Below, a description will be given of the technical levels of the foreign affiliates and local companies.

[2]-1. Foreign affiliates

(a) These companies have introduced equipment and technology from Japan, Italy, West Germany, etc. and are receiving training and guidance from the overseas manufacturers, so the quality of their products is good - equivalent in technical level to the medium class in Japan.

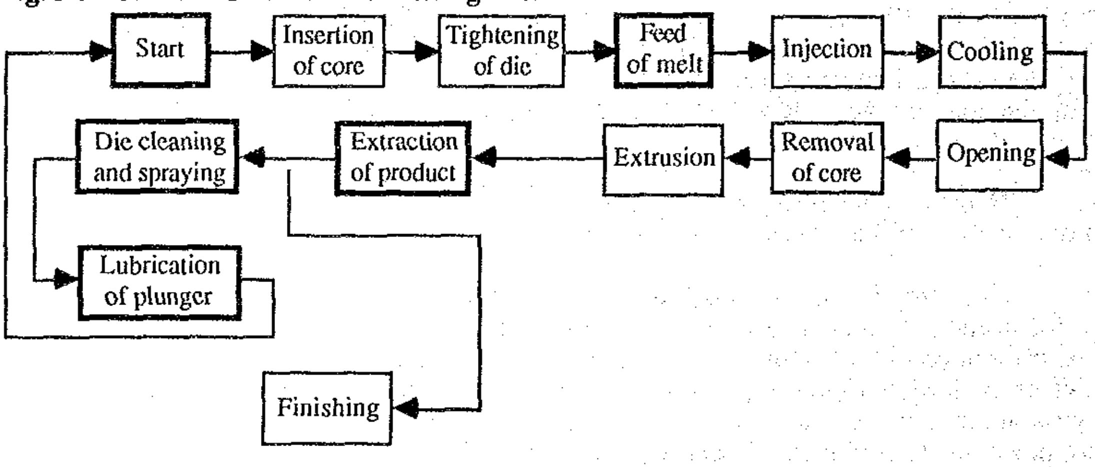
(b) All factories rely on manual labor for their production. There is almost no interest in labor saving or automation in casting. Several companies are automating their melt feed machines, but only one company has installed both automatic melt feed machines and automatic sprayers. The purposes of the automation are i) reduction of the number of workers, ii) stabilization of quality, and iii) improvement of productivity, i.e., not simply the replacement of manual labor by machines, but a significant contribution to the improvement of quality.

In promoting automation, it is first necessary to study the operating systems of production lines and then closely analyze the individual processes. That is, one analyzes the elements of the processes performed by hand labor and replaces them with automatic equipment with the ability to handle the same.

To obtain stable quality, it is important to control the melt temperature, die temperature, and rate of flow and temperature of the cooling water. It is essential to establish such measurement and control systems. Further, to improve productivity, it is important to stress the stability of the casting work and to eliminate trouble in the die-cast machines, dies, and peripherals.

Below, a flow chart of the general die-casting work (cold chamber) is shown.

Fig. 3-3-25: Flow Chart of Die Casting Work

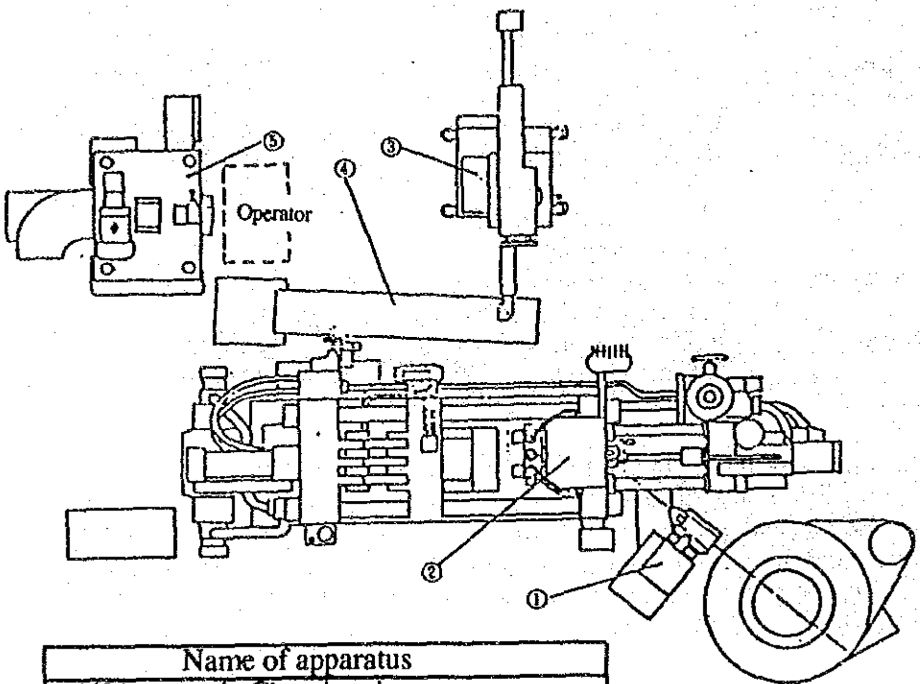


In the above flow chart, the processes enclosed by broad lines are performed by manual labor. This manual labor may be replaced by the following automated machinery.

Manufacturing process	Manual work	Automatic apparatus
Charging	Charging in shot sleeve	Automatic charging apparatus
Removal of product	Removal of product from die	Automatic product removal apparatus
	Conveyance of product to trimming die	"
Cleaning and spraying of die	Cleaning of die and spraying of die lubricant	Automatic spraying apparatus
Plunger lubrication	Coating of plunger lubrication oil	Automatic plunger tip lubrication apparatus

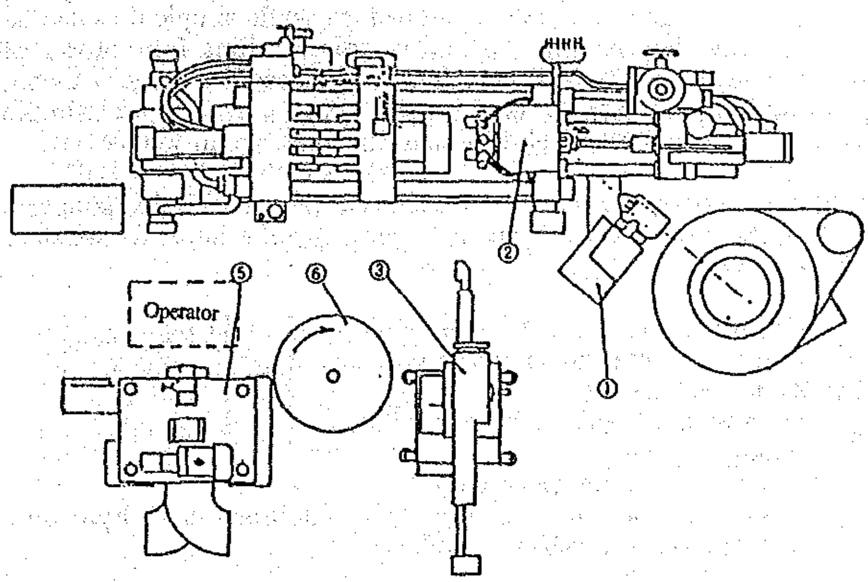
Three examples of the layout of the automated machinery are shown below. In Fig.3-3-26, both the automatic product removal apparatus and the trimming press are installed behind the diecasting machine, while in Fig.3-3-27 the automatic product removal apparatus and the turntable are put together in front of the diecasting machine so that the machine operator can trim the products. Fig.3-3-28 shows an example of the layout of a diecasting production line.

Fig. 3-3-26: Layout of Automated Diecasting (Case 1)



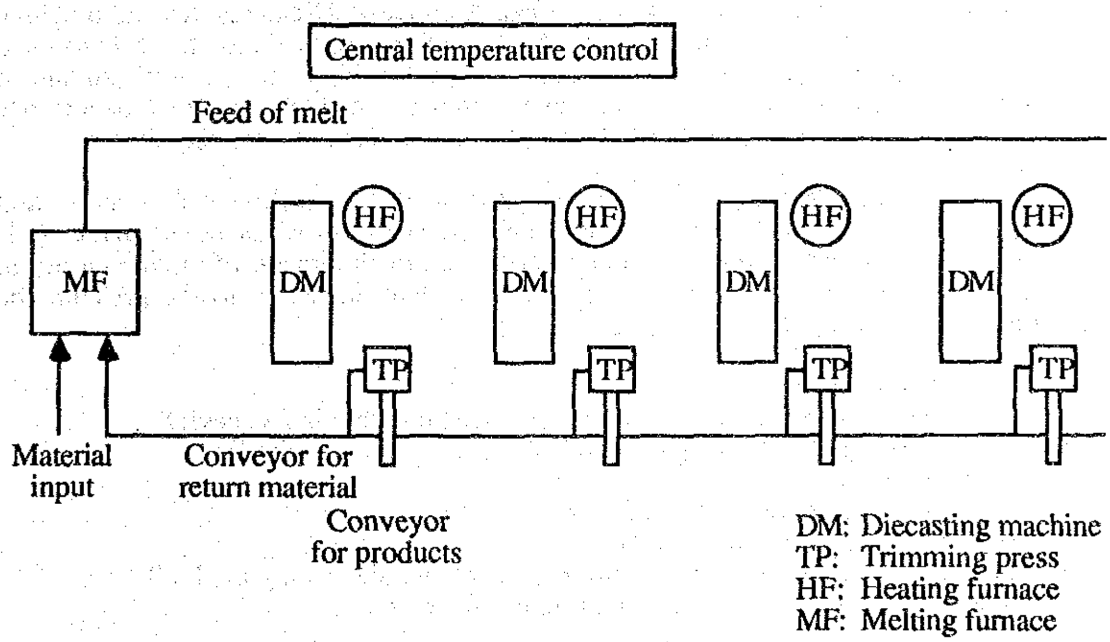
Name of apparatus
[1]Automatic Charging Apparatus
[2] Automatic spraying apparatus
[3] Automatic product removal apparatus
[4] Conveyer
[5] Trimming press
[6] Turntable

Fig.3-3-27: Layout of Automated Diecasting (Case 2)



Name of apparatus
[1]Automatic Charging Apparatus
[2] Automatic spraying apparatus
[3] Automatic product removal apparatus
[4] Conveyer
[5] Trimming press
[6] Turntable

Fig. 3-3-28: Example of Diecasting Production Line



(c) As mentioned earlier, the biggest technical problem in the Indonesian die-casting industry is the dies. With the current level of the Indonesian industry, the technology and skills for design and fabrication of dies are underdeveloped, so while simple dies can be made, complicated high grade dies cannot. Indonesia commissions fabrication of complicated high grade dies to other countries (Japan, Italy, West Germany, Taiwan, etc.) Further, a long period is required from the design to completion for even simple dies, with it taking one year from the start of fabrication to final passage in some cases.

It is necessary to fully understand and master the basics of design, casting theory, and the performance of die-casting machines. The following specific items for mastery may be mentioned:

a) Production specifications and detailed design of products
b) Shrinkage allowance and dimensional precision
c) Mechanical problems and die design
d) Basic design and detailed design of casting systems
e) Design of die cooling systems
f) Die lifetime (heat check, welding, wear, etc.)
g) Behavior of injection machines of die cast machines and hydraulic considerations in conditions for charging products

The final stage of die design and fabrication is the heat treatment and surface treatment, but there are few factories in Indonesia which are provided with suitable die heat treatment or surface treatment facilities. The lifetimes of the dies which are fabricated is short, which is a major factor obstructing production. Study of the installation of heat treatment and surface treatment facilities is of great urgency for companies.

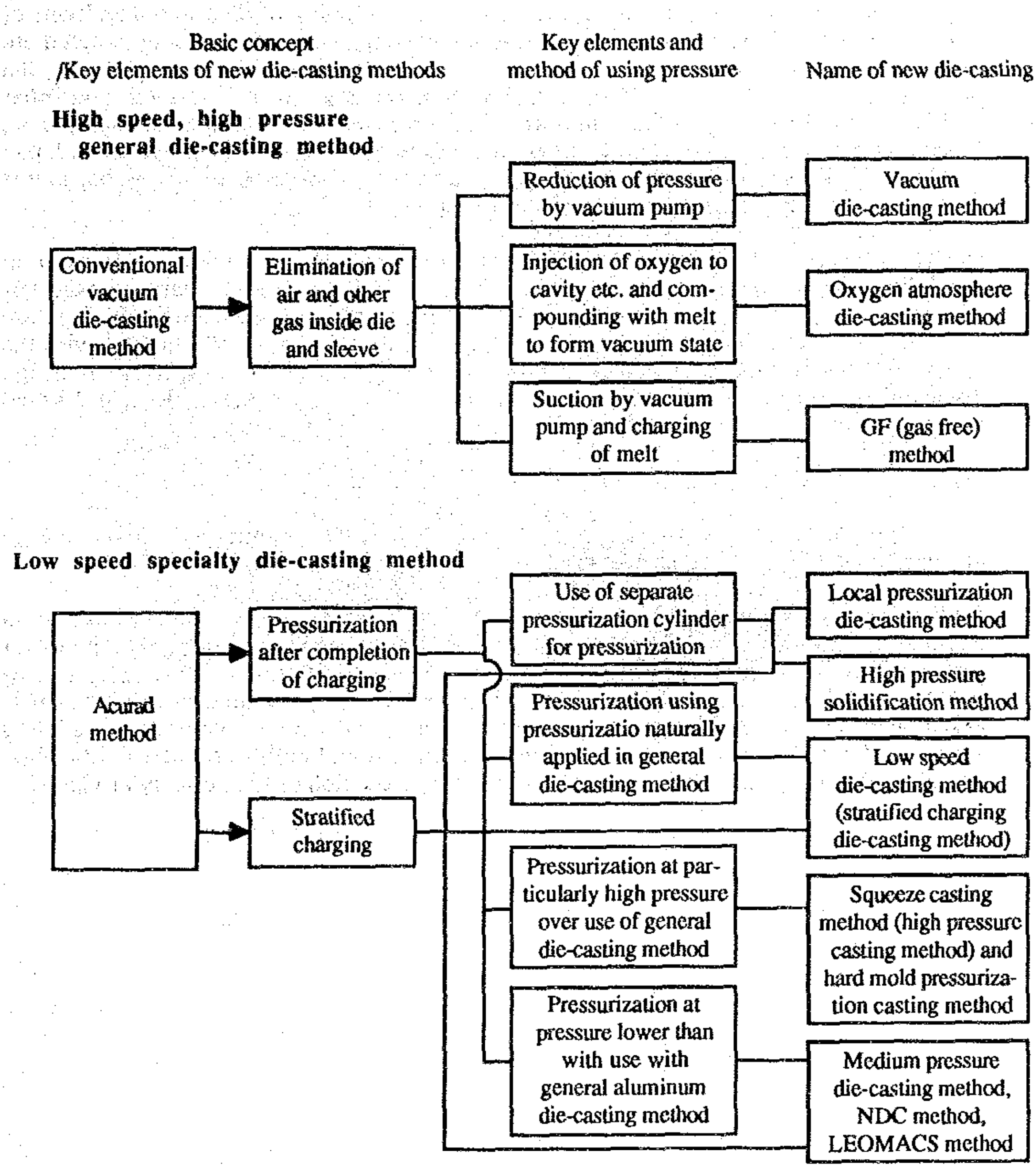
(d) In numerous companies, an insufficient system of control was observed over the maintenance of the die casting machines and dies. There was a strong tendency to deal with problems as they occurred, with few places devising measures to prevent trouble in advance. It is necessary to establish inspection points for each day, week, month, three months, six months, and one year.

(e) One of the main defects of products is defective porosity. Die measures and machine measures to deal with this are insufficient. There is a frequent tendency to deal with just the casting conditions, with no fundamental measures thus being taken. In the advanced countries, such as Japan, various methods have been developed to prevent the occurrence of porosity, so a suitable method should be employed to reduce the porosity defect.

This is being dealt with by just the gates of dies, overflow well system, and treatment for adjusting the casting conditions and no progress is being made. It is necessary to study further how to reduce the pressure of the inside of the die cavity to make a vacuum and charge melt without air being entrained. Up to the present, the following methods have been developed:

a) Vacuum die-casting method
b) Reduced pressure die-casting method (reduced pressure inside cavity)
c) PF die-casting method (oxygen atmosphere die-casting method)
d) GF (gas free) method
e) Local pressurized die-casting method
f) High pressure coagulation method
g) Low speed die-casting method (stratified charging die-casting method)
h) Squeeze casting method (high pressure casting method)

The following is obtained if illustrating these:



(f) The foreign affiliated companies in general have foreign engineers controlling the processes and providing technical guidance, but there is a shortage of medium level engineers between them and the workers on the production floor, which obstructs improvement of productivity, integrated production, including of dies, and development in the area of R&D. The reasons why medium level engineers are not being fostered are the poor rate of settlement in the job, with workers leaving the company during the process of training, the lack of basic technical knowledge even if trained, and other problems with the quality of the manpower. At the present time, taking as an example the Japanese affiliates, only about 60 to 70 percent of the productivity of companies in Japan is achieved. Medium level engineers play extremely important roles in production, so it is necessary to quickly consider measures to deal with this.

(g) The quality of the aluminium alloy material produced in Indonesia is poor in reliability. The technology for melting and refining materials is rudimentary, so materials cannot be used without worry. Further, several companies have pointed out that there are numerous errors in the list of components attached to the alloys. In actuality, with the except of one company which was procuring about 20 percent of its total usage domestically, almost all other companies relied on imports for their alloy.[2]-2 Local companies

[2]-2 Local companies

The local companies suffer from all of the technical problems faced by the foreign affiliates plus the following problems:

(a) First of all, the layout of the production facilities is poor. Local companies have cold chamber machines for producing aluminium die castings and hot chamber machines for producing zinc die castings arranged adjoining to each other. This inevitably causes problems of intermixture of materials and gives birth to poor quality products. It is essential to install machinery and equipment used for different materials completely separate. If possible, it would be desirable to install casting facilities for aluminium alloy and zinc alloy in separate buildings so as to ensure production of high quality products.

Photo 3-3-13: Production Facilities of the Domestic Diecasting Manufacturers

(Production of aluminium diecasting and zinc diecasting is done side by side and thus materials are often mixed)

(b) Second, mention may be made of the lack of temperature control. Local companies are almost completely disinterested in temperature (melt temperature and die temperature), a basic of die castings. In particular, in cold chambers, there are no thermometers in the holding furnaces so it is not clearly known at what temperatures the products were cast. The melt temperature and the die temperature are extremely important and have a large effect on the product quality, so have to be well controlled. The melt temperature varies tremendously, particularly in the case of melting and holding the temperature of an alloy in a holding furnace, so caution is required. The hot charge system where the alloy materials are melted in separate melting furnaces and the melt supplied to the holding furnace features less of a variation in melt temperature, so is more preferable.

(c) The storage and handling of products are rough. In the work for removing the gates, overflow wells, etc., the products are rolled on the ground, placed one by one on a table, and treated by tools, which easily results in dents or scratches in the products. Further, good products with the gates, overflow wells, and casting burrs removed are piled up on the ground. This is very liable to cause scratches on good products or lead to mixture of good and poor products. The basic thing is to improve the deburring (work for removal of portions not belonging to the product) and the method of storage of good products.

Photo 3-3-14: Removing Burrs from Products

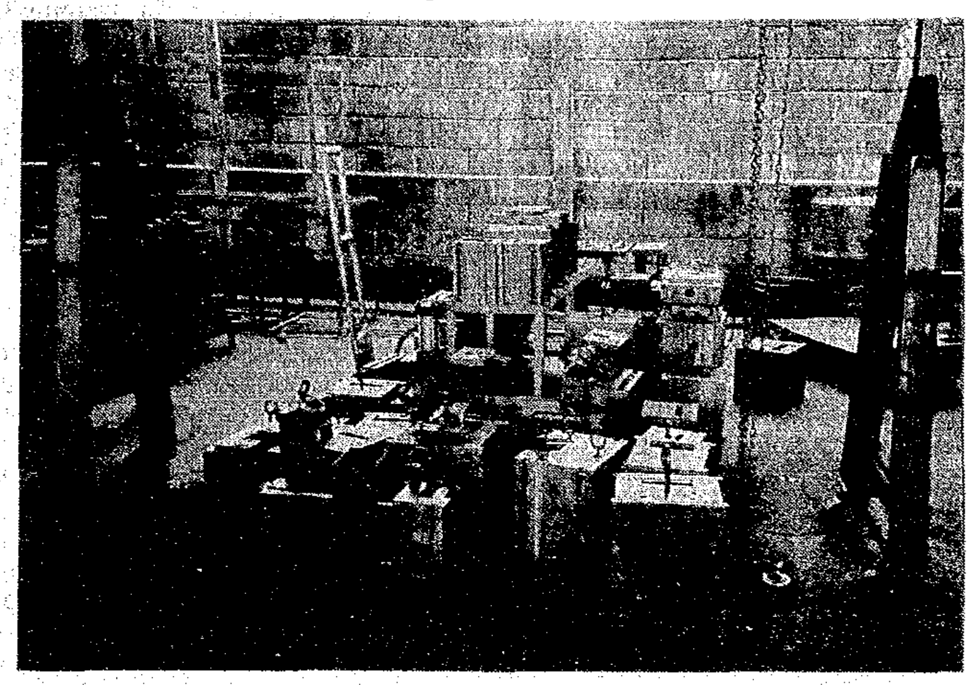
(Removal of burrs is rough. An iron plate piece is used as a tool and this easily damages good products)

(d) The way the dies are maintained and stored is unsuitable. Local companies place stored dies directly on the ground, which is not desirable in that they are liable to collect dust and foreign matter. It would be desirable to prepare suitable tables and store the dies on the same. What should be watched at that time is that the aluminium etc. adhering to the dies after casting be removed completely and, if possible, the dies be washed and coated with rust preventing oil for storage. At that time it is important that soldering portions be polished, dimensions corrected, and troubles with functional portions (ejector pins, movable cores, guide pins, sprue bushes, distributors, cooling pipes) be corrected. During these corrections, it is vital that not only corrections of trouble spots be made, but that any other unstable areas be positively corrected. In particular, spare core pins, which suffer from heavy wear, be always kept on hand.

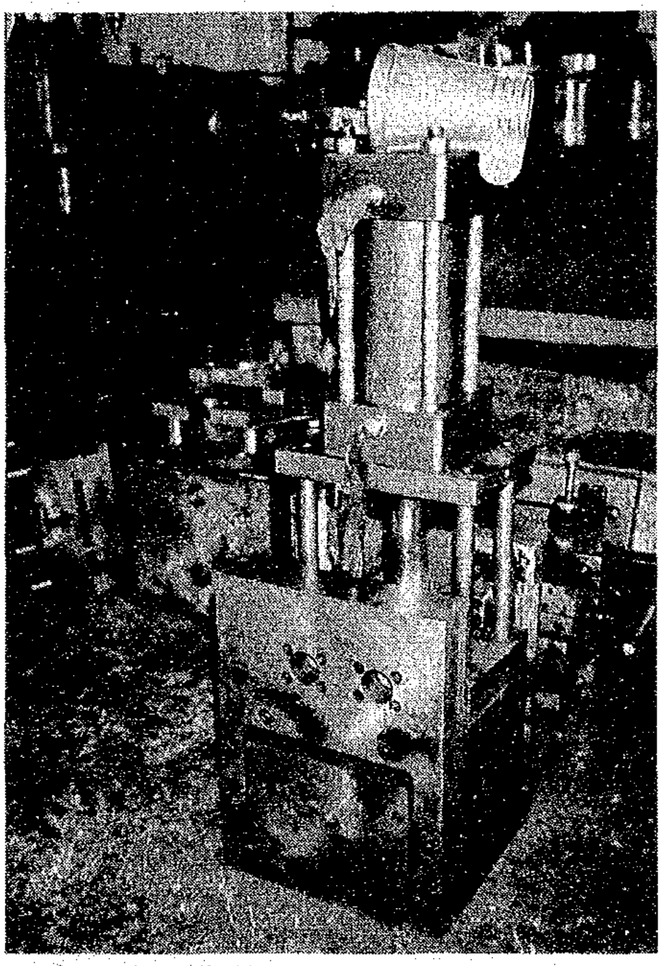
The black oxide film of the cavity surface is mainly composed of Fe_3O_4 and is important for its action in easing heat shock and its heat insulation and lubrication effects. Therefore, it should not be carelessly polished away. Also, this film is destroyed by red rust caused by adhering water drops, so a rust preventing agent should be applied to protect it.

In Japanese companies, repaired dies are labeled as having been repaired and stored in predetermined locations along with ejection rods, core plugs, plunger tips, cooling pipes, and other related parts. In summary, measures are taken so that absolutely no trouble will occur at the next time of casting. Local companies do not perform this type of control and place repaired dies and unrepaired dies carelessly together, with related parts, on the floor.

Photo 3-3-15: Stock of Diecasting dies



(Diecasting dies are placed directly on the ground and there are foreign particles on the surface)



(The surface of the die is stained with rust due to poor care)

(e) Local companies give almost no in-house training to their workers. Periodic training of workers would lead to the development of medium level engineers. The training should be on the basics of die casting and include everything from the very simple facts to the alloys, dies, die casting machines, casting, quality, and safety. Further, higher level managers must be trained in the analysis of prime costs. A look at the present state of local companies, however, shows first of all that the training should start with organization and orderliness. They are important measures for the promotion of safety control, so much so that it is said that safety starts with organization and orderliness and ends with organization and orderliness.

Organization and orderliness specifically include the following:

Organization:	Necessary and unnecessary items should be separated and unnecessary items be immediately removed from the work area.
Orderliness:	Necessary items should be arranged neatly for the greatest ease of use so that they can be used at any time.
Cleanliness:	One's own workplace should always be kept clean. A workplace cannot be said to be clean just because the floor is clean.
Neatness:	Organization, orderliness, and cleanliness should be maintained. These should be stressed to all employees through training until they become habits. It is important to thoroughly supervise employees until these habits become entrenched. This is an essential requirement for eliminating waste and should be tackled first off.

By thoroughgoing organization and orderliness, it may be expected that i) cramp space can be made better use of, ii) the work place will become brighter in atmosphere and work order will naturally become more natural, iii) it will take less time to locate things and efficiency will improve, iv) worries over fire will be eliminated, and v) tripping, slipping, and other accidents will be eliminated.

Photo 3-3-16: Handling of Products

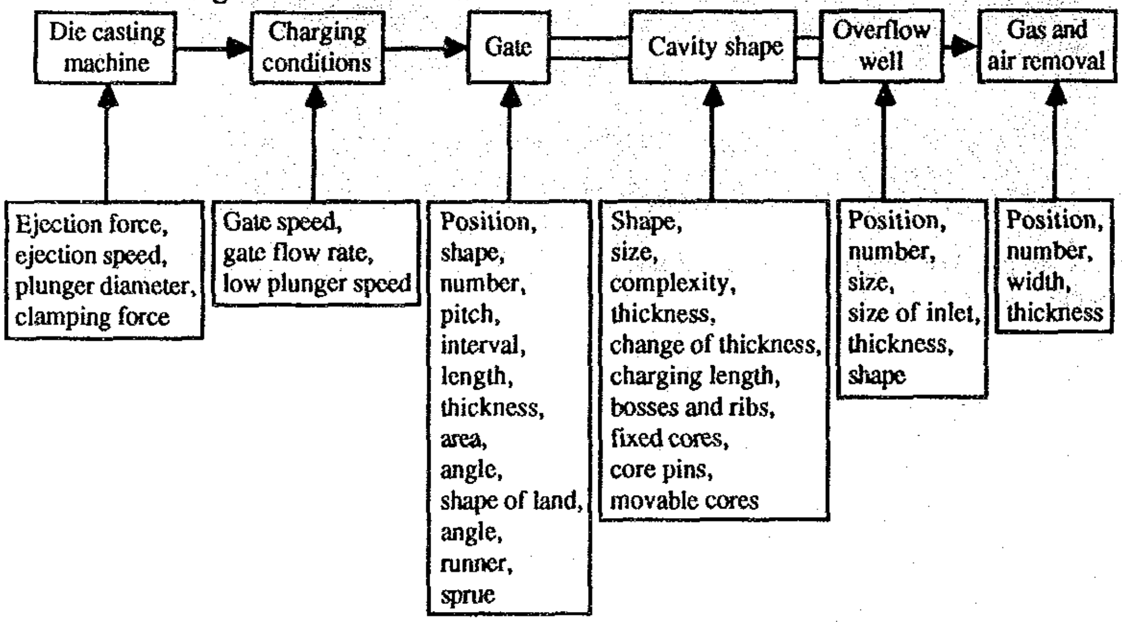
(Products are piled on the floor and it is difficult to distinguish defective products from good ones)

[3] Product development

Among the foreign affiliates, there are few examples of independent product development. These companies obtain almost all their die casting designs from the parent companies in Japan, Italy, West Germany, etc. Simple shapes can be designed in-house, but complicated ones are still not possible technically. Designs are not things which can be made overnight. They are the results of long years of experience and accumulated knowledge. Good designs are only possible after acquiring the basic knowledge of die casting and having experience in casting work. By introducing foreign technology, feeding back the results of casting of die castings designed and manufactured, and preparing manuals of design schemes giving good products, it would become possible to accumulate technical knowhow and gradually design more complicated items.

The basic knowledge would include (a) product designs, (b) die designs (dynamic issues), and (c) basic design of casting schemes. The specific items and conditions which should be considered are given below. It is only when these conditions are all present that good design of die castings becomes possible.

Fig. 3-3-29: Specific Design Items and Conditions to be Considered in Casting Schemes



Future fields which should be developed include auto parts, motorcycle parts, electrical equipment, communications equipment, electronic components, and daily use items. In particular, a surge in demand is expected in the field of parts for transport machines and electrical and electronic components and it is necessary to develop these strategically.

[4] Factory control

(a) Process control

The work of process control is to reduce the obstacles which cannot be avoided and smooth daily production activities. Smooth production work means a good combination of the 5M's, i.e., materials, machines, methods, men, and money. It is necessary to ensure that products of a predetermined quality be able to be produced easily, quickly, and cheaply to meet delivery commitments.

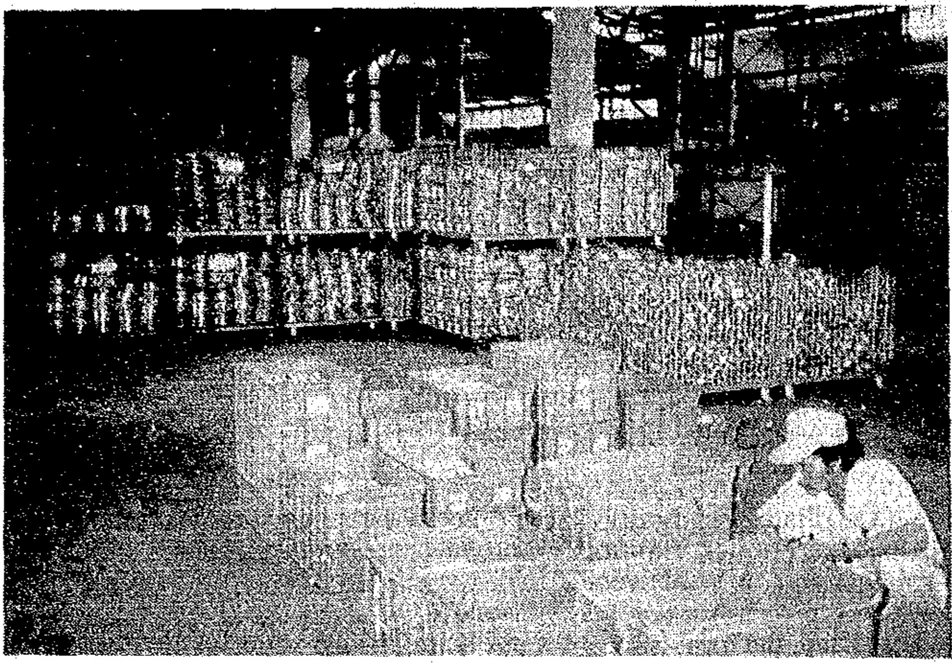
The foreign affiliates basically perform control in accordance with the process control of their parent companies and find these to be functioning effectively. The local companies, however, suffer from deterioration of the initial performance and breakdowns of their machines due to ageing, rough work methods, unsuitable execution of work, and a lack of awareness on the part of the workers, so the work of moving from one process to the next is not performed smoothly.

(b) Stock control

The foreign affiliates neatly divided and box their stock. The transfer among workplaces is also good. Further, semifinished products are stored in special containers. The stock control, therefore, is good overall.

On the other hand, the local companies pile semifinished items on the floor. Even when handling stock, they randomly place it on the floor and thus exercise substantially no stock control.

Photo 3-3-17: Stock Control at a Foreign Affiliated Company



(Products are sorted by type and stored in an orderly way in different boxes)

Photo 3-3-18: Stock Control at a Domestic Company

(Different products are piled together in a haphazard manner and this causes mixing of different parts and defective products)

(c) Control of workplace

There is a large gap between foreign affiliates and local companies in control of work methods in the same way as with stock control. The local companies perform work based on certain predetermined methods, but do not standardized or semistandardized products. It is necessary to eliminate the variations in the work of individual workers and to produce items of a stable quality by establishing standardized workplace control.

(d) Control of environment

The workplace environment is a factor having a large effect on work efficiency. Foreign affiliates generally have good workplace environments. For example, their layouts are orderly, worker clothing is neat, and the 5S's (organization, orderliness, cleanliness, neatness, and appearance (in Japanese, all "s" words) are advanced. Compared with this, the local companies almost completely ignore organization, orderliness, and cleanliness. Observation was made of unsuitable factory layouts, items considered unnecessary, soot and rubbish, lack of removal of dust etc., untidy clothing on the part of the workers, etc. It is necessary to quickly promote more thorough organization, orderliness, and cleanliness. Further, it is necessary to imprint on the workers' minds and thoroughly promote "constant readiness" and "safety first" for safe work.

[5] Quality control

Quality control is said to be "one of the systematic means for achieving the quality demanded by the purchaser economically and to build in quality into every process". In die casting, the manufacturer and customer discuss technical aspects and decide on the specifications to which products are to be made. Then, first, production plans are set up and the specific processes, means, and methods for making the product are decided on and the quality control process chart defining these is made. Next, written work standards (instructions), inspection standards, etc. are prepared for the product for each determined process and these used for the work and inspection and testing.

Foreign affiliates are performing this series of quality control to a certain extent, but there were still many points observed requiring improvement. For example, while the quality control was systemized in a sense, many companies were not following it as originally intended in actual operations. While they realized that it had to be done, they were not doing it in many cases due to the absence of the core middle level manpower. It is important that companies as a whole tackle quality control activities so as to make better quality products and therefore the following activities are required:

(a) Raising the awareness of quality control among all workers

a) When instructing workers on work, careful instruction should be given on the quality required for the product. Further, the workers should be impressed with the fact that quality control would lead to greater profits.
b) It is important to keep machinery and tools neat at all times. Unnecessary matter should be disposed of and the necessary machinery and tools periodically maintained so as to enable them to be used as intended at all times.
c) The inspections of initial casting products in mass production should be improved. In mass production, the first casting products are the most important, so they should be fully inspect so as to prevent defects from occurring later. Further, suitable inspections in the middle of the processes are also important.

(b) Placing the responsibility for quality control on the workers

a) The workers should be educated. That is, they should be made aware of quality and learn more about their work and be given the knowledge and knowhow on what they should do to achieve better quality and the skills to do the same.

[6] State of Factories

The state of the production areas at the aluminium diecasting manufacturers was surveyed based on a "factory check list". The survey was conducted on five diecasting companies. These companies include four foreign affiliated companies, all of which are motorcycle assemblers who produce mostly diecast motorcycle parts to be assembled in-house, and one domestic Indonesian company which is an exclusive diecasting manufacturer producing parts for speakers, motorcycles, etc., as a subcontractor. A summary of the results of the survey of the domestic company and the four foreign affiliated companies is given separately in Table 3-3-52.

As shown in the table, great differences were observed between the foreign affiliated companies and the local company, many more than were observed among manufacturers of other aluminium products. Foreign affiliated companies are all equipped with up-to-date production facilities and employ the latest technology as well as various production know-how introduced from their foreign principal companies, including training of employees by foreign experts. On the other hand, the local company, which was awarded 1 point on all the evaluation items, is said to have problems in all areas of production and technology and labor management.

Table 3-3-52: Results of the Field Survey at Factories (Diecasting)

Evaluation Item	Check Points	Average Points Domestic	Average Points Foreign
Production and technology			
Work management			
1. Dispatched workers	• Level of automation, Job range	1	2.8
2. Speed of operation	• Earnest attitude, A look in eyes, A chat during work (talking during work?)	1	3
3. Working speed	• Speed of manual work, Working speed	1	3
4. Operation efficiency	• Frequency of operation stoppage, The number of workers walking about, Meetings	1	2.8
5. Management style	• Posting of notices regarding production targets and achievements, posting of notices regarding attendance	1	3
6. Operation improvement	• The amount of wastefulness, Improvements in jigs and fixtures	1	3
Product management			
7. Materials, parts	• Containers, Storage methods, Manner of piling, Use of shelf labels	1	3
8. Semi-processed products	• The degree of accumulation, Use of stock slips	1	3
9. Finished products	• Types of packing, Cleanness of packages	1	3
10. Material handling	• Notice of storage space, Transportation method, Manner of placing	1	3
Quality control			
11. Process inspection	• Posting of notices regarding inspection standards, The level of inspection skill, Boundary samples	1	2.8
12. Handling of defective products	• Notices regarding defective units, Classification of storage spaces	1	2.8
13. Inspection equipment	• Manner of handling, Inspection marks	1	2.8
14. Management method	• Control charts, Posting of notices of defect and other ratios	1	2.8
Plant management			
15. Factory layout	• The level of adopting assembly line, The level of continuous operation	1	3
16. Maintenance of equipment	• Soil on equipment, Proper pipe laying and wiring	1	3
17. Maintenance of building	• Uneven floor, Broken windows, Coloring, Rain-cover, Roof leakage	1	3
Labor management			
Working environment			
18. Proper arrangement	• Establishment and indication of aisles, Manner of placing jigs and fixtures	1	3
19. Clothing	• Uniform and regulation cap, Work shoes, Name tag	1	3
20. Lighting	• Lighting levels, Lighting method	1	3
21. Ventilation	• Dust, Foul odors, Windows, Ventilating fans	1	3
22. Rest area	• Existence of space for a rest area	1	3
Safety & sanitation			
23. Safety	• Posting of danger signs, Use of safety equipment, Posters promoting safety in operations	1	3
24. Sanitation	• Cleaning of building and aisles, existence of a sashhand stand	1	3
Morale			
25. Motivation	• Existence of a bulletin board, Existence of a quality control bulletin board, Posting of a company slogan	1	3

Source: Factory survey

[7] Procurement of raw materials

Almost all companies are importing aluminium die casting alloy materials from other countries (Australia, Japan, Italy, Taiwan, etc.) The widest use is made of alloy material equivalent to ADC12 of the JIS (Japan Industrial Standard). The imported material is suitably processed in terms of melting and refining and there are no particular problems with the composition or entrained oxides etc. However, while there are no problems quality wise, as they are imports, there are problems of price and stability of supplies. If the materials could be procured domestically, these problems could be solved, but with the present levels of quality, it would not be easy to use domestic materials. The melting, refining, and compositions are unsuitable and reliability is poor, so many foreign affiliates will not use domestic alloys.

Almost all die casting facilities, such as dies, alloys, and die casting machines, are imported. In the future, domestic production will be promoted, starting with the alloy materials. For this too, effort should be made to quickly produce material of a reliable quality and to get it used by companies.

[8] Relationship with supporting industries

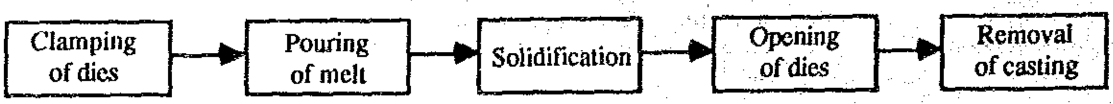
The quality of the dies plays an important rôle in die casting, so much so that it is said that seventy to eighty percent of the quality of die castings is governed by the quality of the dies. The quality of dies refers to the quality of the i) die design, ii) die fabrication, and iii) die heat treatment and surface treatment. At the present time, almost all companies are importing their dies. Simple dies are fabricated in-house as well and there are specialized manufacturers too, but the industry relies on imports for complicated dies. IDMMI, ITB, Swiss Polytechnic, and other government research and educational organizations are proceeding with development efforts, but their efforts have only brought them to the level where they can make simple dies. Complicated dies are fabricated through acquisition of basic design theory and the building up of experience. The domestic diemaking facilities are not necessarily old-fashioned, but it is considered necessary, in terms of promoting the Indonesian die casting industry in the future, to further improve the facilities and acquire the theory, experience, and knowhow to make the design and fabrication of high quality dies possible.

5) Other Casting Methods

Casting methods for producing aluminium cast products in addition to die casting include the permanent mold casting method and the low pressure die casting method.

[1] Permanent mold casting method

Permanent mold casting of aluminium alloy is used for the purpose of making high quality castings with dense structures by utilizing the rapid cooling effect of the dies and is used as a means of mass producing general castings. Usually, the latter is the main objective. This casting method makes repeated use of the dies, has the melt poured into the dies by gravity, has the dies opened after the melt has solidified, and then the casting taken out. That is, one cycle of the casting process becomes as follows:



A key point in permanent mold casting machines is the mechanism for opening and closing the dies. Almost all machines are of the same operating systems as die casting machines. The dies are opened and closed manually, pneumatically, or hydraulically. In

Indonesia, the main systems used are manual and hydraulic ones. These are used for vertical dies (opening vertically) and horizontal dies (opening horizontally). The dies are almost all imported from other countries (mainly Japan and Taiwan). There are a few local die makers as well, but they cannot offer stable supply. The products are mostly automobile and motorcycle pistons. No particular problems have occurred with quality, but pinholes have occurred in some companies due to the large margin for lathing. First, this margin has to be reduced, but in reality there are almost no engineers able to make such designs.

Compared with die casting, the technology is easy, so the local companies are doing well overall in their production activities, but they are being pressed to introduce advanced overseas production technology through, for example, periodic training in other countries (Japan, Taiwan, etc.)

[2] Low pressure die casting method

The low pressure die casting method includes the following processes. First, an air pressure (or inert gas) of 0.1 to 0.5 atmosphere is applied to the surface of the melt in a sealed crucible. The melt is poured into the die through a stalk in the melt. After the metal in the cavity solidifies, the pressure is returned to atmospheric pressure. The casting sticks to the upper die half and separates from the lower die half and is ejected by an ejection mechanism built in the upper die half. The low pressure die casting method is somewhat more complicated than the permanent mold casting method. The casting machines are considerably automated.

The flow of the low pressure diecasting method is as below. Fig.3-3-30 shows the flow of production from the raw material aluminium ingot to the shipment of the finished products. Fig. 3-3-31 shows one production cycle of one diecasting machine which is only one part of the entire production flow. This cycle repeats to produce diecasting.

Fig. 3-3-30: Flow of Low Pressure Diecasting Production

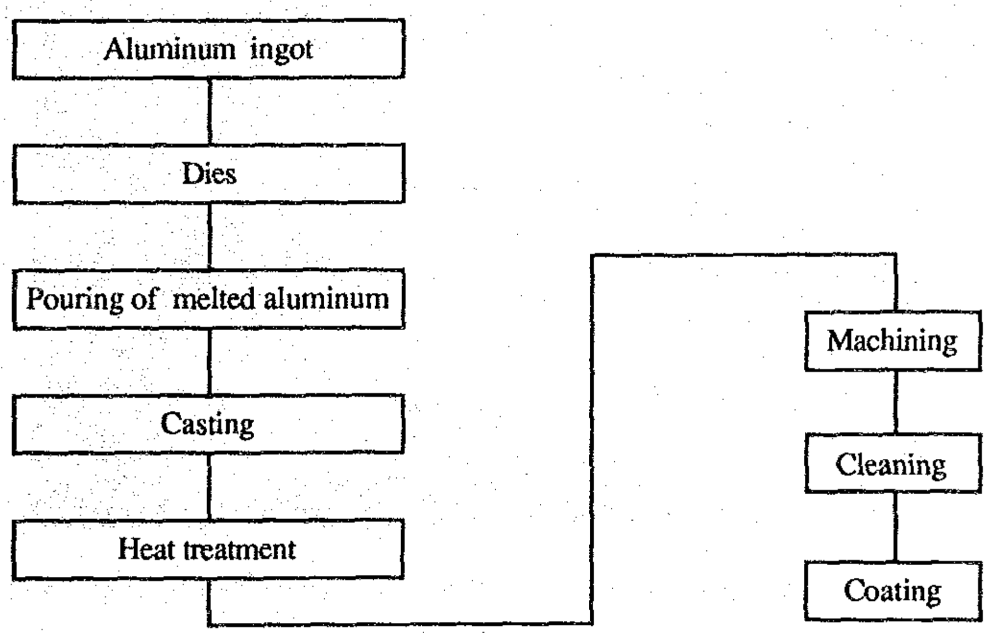
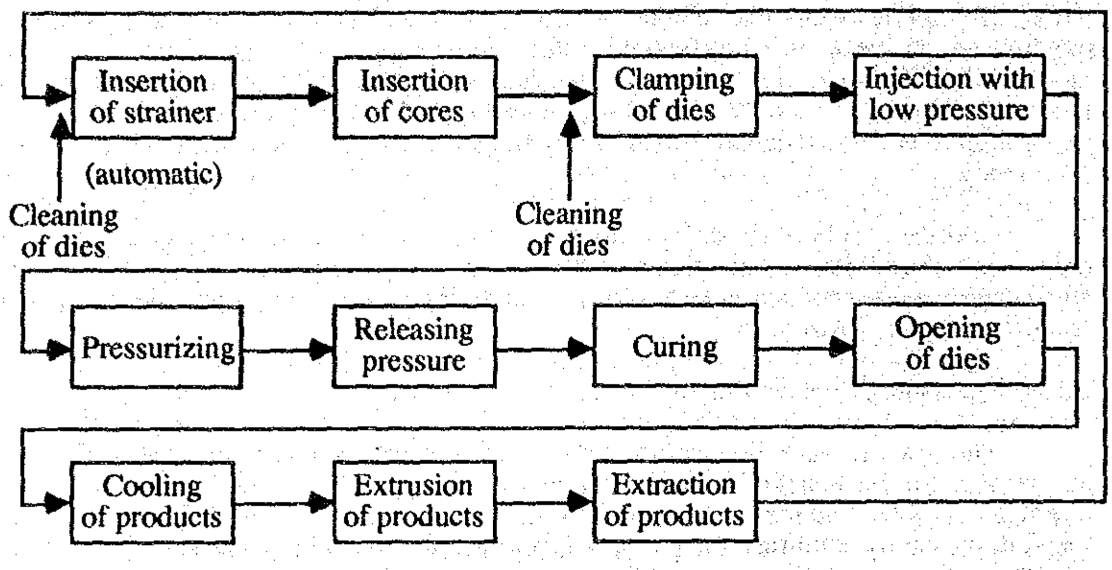


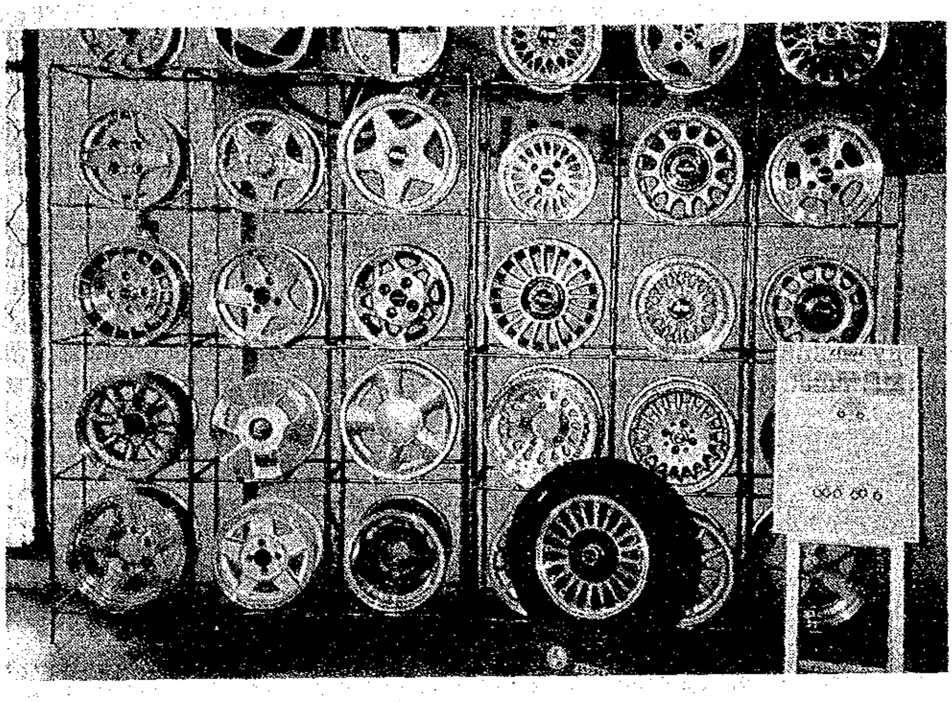
Fig. 3-3-31: Low Pressure Diecasting (1 cycle)



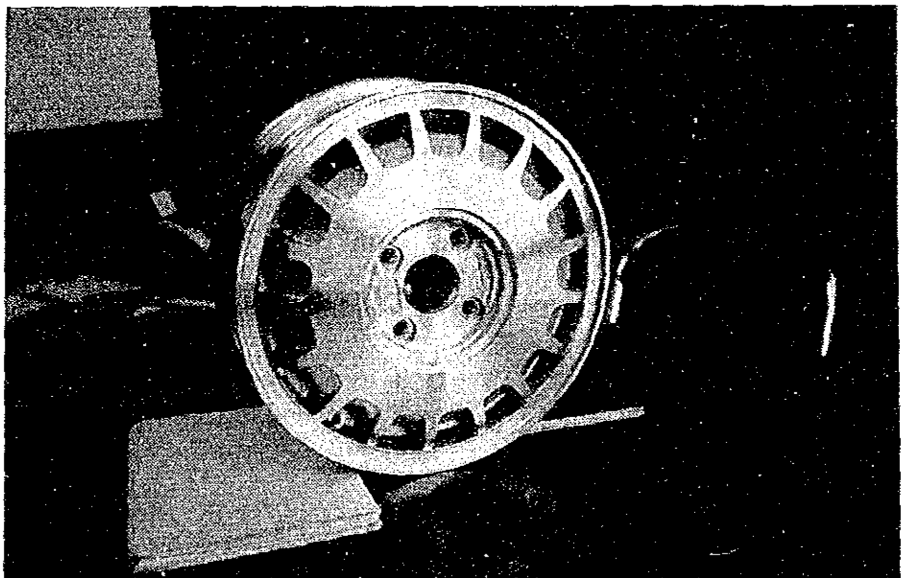
Two companies are engaged in production in Indonesia by the low pressure die casting method. One of these has introduced technology from West Germany and the other from Japan. They are well equipped with testing facilities and have high levels of technical expertise. Spare dies are kept on hand at all times, the work standards are well laid out, and the production system well set up. Both the companies produce aluminium wheels for automobiles and motorcycles. Technical problems include, in one company, a high (about 15 percent) defective rate. The main defects are remaining black film, porosity, and leaks. The products shipped out by both the companies are technically sophisticated. In particular, one company currently exports 40 percent of its products and in the future plans to increase exports further.

Overall, aluminium wheels made by the low pressure die casting method are of a high technical level and a technical ripple effect may be expected to other aluminium processing fields, so continued effort to improve the level of technology would be desirable.

Photo 3-3-19: Aluminium Wheels produced by Low Pressure Diecasting



(The quality of products meets international standards and thus most of the products are exported to advanced countries.)



(A sample product manufactured using Japanese dies and meeting industrial standards)

[3] State of Factories

For the one Indonesian company, which runs a permanent mold casting factory, the state of the production areas was surveyed based on a "factory check list." Two low pressure diecasting companies and the other permanent mold casting company are not included in the survey because the JICA Study Team did not have the chance to observe the factories of the former and the engineers at the latter were absent when the Study Team visited the factory and thus technical matters were not discussed. A summary of the results of the survey of the one Indonesian company is given in Table 3-3-53.

According to the results of the survey, the factory was clean by the standards of the Indonesian aluminium industry. No serious problems were found in the area of labor management. Some problems observed by the Study Team in the area of production and technology include control of semi-processed products in products management and handling of defective products and management methods in the area of quality control.

Table 3-3-53: Results of the Field Survey at Factories (Permanent Mold Casting)

Evaluation Item	Check Points	Average Points
Production and technology		
Work management		
1. Dispatched workers	• Level of automation, Job range	2
2. Speed of operation	• Earnest attitude, A look in eyes, A chat during work (talking during work?)	2
3. Working speed	• Speed of manual work, Working speed	2
4. Operation efficiency	• Frequency of operation stoppage, The number of workers walking about, Meetings	2
5. Management style	• Posting of notices regarding production targets and achievements, posting of notices regarding attendance	2
6. Operation improvement	• The amount of wastefulness, Improvements in jigs and fixtures	2
Product management		
7. Materials, parts	• Containers, Storage methods, Manner of piling, Use of shelf labels	2
8. Semi-processed products	• The degree of accumulation, Use of stock slips	1
9. Finished products	• Types of packing, Cleanness of packages	2
10. Material handling	• Notice of storage space, Transportation method, Manner of placing	2
Quality control		
11. Process inspection	• Posting of notices regarding inspection standards, The level of inspection skill, Boundary samples	2
12. Handling of defective products	• Notices regarding defective units, Classification of storage spaces	1
13. Inspection equipment	• Manner of handling, Inspection marks	2
14. Management method	• Control charts, Posting of notices of defect and other ratios	1
Plant management		
15. Factory layout	• The level of adopting assembly line, The level of continuous operation	2
16. Maintenance of equipment	• Soil on equipment, Proper pipe laying and wiring	2
17. Maintenance of building	• Uneven floor, Broken windows, Coloring, Rain-cover, Roof leakage	2
Labor management		
Working environment		
18. Proper arrangement	• Establishment and indication of aisles, Manner of placing jigs and fixtures	2
19. Clothing	• Uniform and regulation cap, Work shoes, Name tag	2
20. Lighting	• Lighting levels, Lighting method	2
21. Ventilation	• Dust, Foul odors, Windows, Ventilating fans	2
22. Rest area	• Existence of space for a rest area	2
Safety & sanitation		
23. Safety	• Posting of danger signs, Use of safety equipment, Posters promoting safety in operations	2
24. Sanitation	• Cleaning of building and aisles, existence of a sashhand stand	2
Morale		
25. Motivation	• Existence of a bulletin board, Existence of a quality control bulletin board, Posting of a company slogan	2

Source: Factory survey

6) Quality of Raw Materials

Aluminium products are roughly divided into two categories by the type of materials used: (i) rolling and extrusion, and (ii) diecasting and other castings.

Rolled and extruded products use, as a material, pure aluminium or aluminium alloy which is mainly composed of pure aluminium. The pure aluminium is supplied by virgin ingots, which in Indonesia are produced solely by P. T. INALUM, and few problems in the quality of the ingot have occurred. Since virgin ingot is an international commodity for which international standards exist, imported ingot is also almost problem-free in terms of quality.

On the other hand, a variety of aluminium alloys is used for production of diecasting and other casting products, depending on what the final product is and where it is used. Each alloy has its own characteristics such as mechanical strength, corrosion resistance, wear resistance, pressure resistance, machinability, and ease of surface treatment. Once the industrial standard number of an alloy is determined, the alloy is produced at factories by mixing recycled ingots and in-house aluminium scrap in accordance with the specifications. In general, the major raw materials used at casting companies are recycled ingots, which are available on the market, and in-house scrap. The usage of virgin ingots is small. In-house scrap easily picks up impurities such as zinc, iron and silicon in levels more than those stipulated by industrial standards and this may lead to inferior products. Accordingly, quality control of raw materials is regarded as very important for the production of quality products.

Taking the above into consideration, the JICA Study Team collected samples of aluminium materials at five companies. These samples were then inspected for chemical composition by the Saitama Prefectural Casting and Machinery Research Institute in Saitama, Japan. These five companies include two domestic diecasting companies, one foreign affiliated diecasting company and two domestic permanent mold casting companies. There were six chemical elements for which the samples were inspected: copper, silicon, magnesium, zinc, iron, manganese and lead, all of which are considered to affect the quality of final products. The results of the inspection are summarized in Table 3-3-54.

Table 3-3-54: Chemical Composition of Aluminium Alloys

Company	Chemical Composition (unit: %)						
	Cu	Si	Mg	Zn	Fe	Mn	Pb
Diecasting							
Company A (domestic)	2.11	9.16	0.20	2.53	1.00	0.16	0.18
Company B (domestic)	3.06	8.37	0.13	1.65	1.39	0.10	0.12
Company C (foreign)	nil	0.08	trace	0.01	0.39	trace	trace
Gravity casting							
Company D (domestic)	1.15	12.24	0.45	0.09	0.73	0.07	0.02
Company E (domestic	1.33	11.70	0.81	0.11	0.69	0.12	0.03

From the results of the inspection shown above, the quality of aluminium alloys used in Indonesia may be summarized as follows:

[1] Alloys for Diecasting

The most popular alloys used to produce diecasting in Japan are JIS (Japan Industrial Standard) ADC10 and ADC12. Both alloys are suitable for producing precision diecasting products with good mechanical strength. The difference between these two alloys is the silicon content. Specifically, ADC12 contains a higher silicon content to improve the flow of the alloy when it is melted.

Aluminium alloys collected at company A and company B, both of which are Indonesian companies, are considered to be equivalent to JIS ADC10 or ADC12. The following table compares the collected alloys with the specifications of ADC10 and ADC12.

Table 3-3-55: Comparison of Chemical Composition with JIS

Company	Chemical Composition (unit: %)					
	Cu	Si	Mg	Zn	Fe	Mn
JIS						
ADC10	2.0~ 4.0	7.5~ 9.5	Below 0.3	Below 1.0	Below 1.3	Below 0.5
ADC12	1.5~ 3.5	9.6~ 12.0	Below 0.3	Below 1.0	Below 1.3	Below 0.5
Sample Alloy						
Company A (domestic)	2.11	9.16	0.20	2.53	1.00	0.16
Company B (domestic)	3.06	8.37	0.13	1.65	1.39	0.10
Company C (foreign)	nil	0.08	trace	0.01	0.39	trace

From Table 3-3-55, it can be seen that aluminium alloys collected at companies A and B are similar to JIS ADC10. By chemical element, copper, silicon and magnesium fall within the JIS standard for both alloys. However, the alloy at company A exceeds the standard for zinc, and the alloy at company B exceeds those for zinc and iron.

The alloy used at company A contains a large amount of zinc and the diecasting products made of the alloy tend to lack heat resistance and strength. Company A produces both aluminium and zinc diecasting products and production lines for both products are installed side by side at the firm's factory. In addition, stock control of both aluminium and zinc materials is not well managed and zinc scrap is easily mixed up with aluminium scrap. This may be the cause of the problem.

Company B also uses alloy with excessive zinc content indicating that the diecasting products made of the material would be lack heat resistance and mechanical strength. In addition to zinc, iron, which comprise 1.39% of the alloy, exceeds the JIS standard. The more the iron content increases, the more fragile the products become. In addition, excessive iron content tends to produce hard spots which lead to a decrease in the machinability of diecasting products. As a matter of fact, in Japan, the iron content is limited to 1.0% at many diecasting factories, even though JIS allows up to 1.3%.

The alloy collected at company C, which is a foreign affiliate, is regarded as pure aluminium. No chemical element but iron comprises more than 0.1% of the alloy. The iron content, which is 0.39%, is considered to make removal of diecasting products from dies easier. The overall control of chemical content is considered well done.

[2] Alloys for Permanent Mold Casting

There are many more types of alloys used for permanent mold casting than there are for diecasting and the characteristics of the final products vary depending on the type of alloy and the method of casting. The Study Team visited two permanent mold casting factories in Indonesia. Casting products produced by both companies are mainly pistons for automobiles and motorcycles. In general, the family of Al-Si-Cu-Ni-Mg alloy is called piston alloy, and AC8A, AC8B, and AC8C under JIS are included in this family. These alloys have good heat resistance, little gas leakage, do not become fragile at high temperature and are easy to cast. The family of Al-Si-Cu-Mg alloy, which contains more silicon than Al-Si-Cu-Ni-Mg alloy, is popular for pistons for 2-stroke engines because the alloy has a small rate of expansion under heat and high wear resistance. AC9A and AC9B under JIS are members of the family. Aluminium alloys collected at Indonesian companies are compared with similar JIS alloys as follows:

Table 3-3-56: Comparison of Chemical Composition with JIS

Company	Chemical Composition (unit: %)						
	Cu	Si	Mg	Zn	Fe	Mn	Pb
JIS							
AC8A	0.8~ 1.3	11.0~ 13.0	0.7~ 1.3	Below 0.15	Below 0.8	Below 0.15	Below 0.05
AC8B	2.0~ 4.0	8.5~ 10.5	0.5~ 1.5	Below 0.50	Below 1.0	Below 0.50	Below 0.10
AC8C	2.0~ 4.0	8.5~ 10.5	0.5~ 1.5	Below 0.50	Below 1.0	Below 0.50	Below 0.10
AC9A	0.5~ 1.5	22~ 24	0.5~ 1.5	Below 0.20	Below 0.8	Below 0.50	Below 0.10
AC9B	0.5~ 1.5	18~ 20	0.5~ 1.5	Below 0.20	Below 0.8	Below 0.50	Below 0.10
Alloy samples							
Company D (domestic)	1.15	12.24	0.45	0.09	0.73	0.07	0.02
Company E (domestic)	1.33	11.70	0.81	0.11	0.69	0.12	0.03

Note: The difference between AC8B and AC8C is nickel content, which is not shown in this table

Judging from the copper and silicon contents, the alloy at company D is regarded as equivalent to AC8A under JIS. When compared to AC8A under JIS by content, only the magnesium content of the collected alloy is below the JIS standard. Although lack of magnesium content tends to have adverse effects on corrosion resistance, machinability, and mechanical strength of the casting products, the content shortage is marginal and not considered a serious problem. On the other hand, the alloy used at company E meets the JIS standard with regard to all contents and thus the alloy does not have any problem with regard to chemical composition.

(2) Present Situation of Management

1) Human Resource Development

[1] Composition of work force

There were 20 responses to the questionnaire and the firms responding varied widely in size from 20 to 697 employees. The number of employees by level and the percentage which each level accounts for out of the total number of employees are shown in Table 3-3-57

Table 3-3-57: Number of Employees by Level

Level	Number of employees	Ratio
Office		
Managerial Staff	100	2.4%
Clerical Staff	239	5.6%
(Sub Total)	339	8.0%
Factory		
Engineers	74	1.8%
Skilled workers	403	9.5%
Semi-skilled workers	590	13.9%
Unskilled workers	2,828	66.8%
(Sub Total)	3,895	92.0%
Total employees	4,234	100.0%

Source: Questionnaire Survey

The make-up of the work force by level is considered to be balanced in that the total number of administrative personnel including both managerial and clerical staff accounts for 8%, a figure regarded as reasonable.

Among factory workers, skilled workers account for 9.5%, while semi-skilled workers and unskilled workers account for 13.9% and 66.8% respectively. Because their wages are relatively low, high numbers of semi-skilled workers and unskilled workers contribute to the reduction of production costs. However, they do not contribute to increasing productivity. To utilize semi-skilled and unskilled workers, it is imperative that they be educated and trained to become engineers and skilled workers.

[2] Problems in labor management

Table 3-3-58 summarizes the results of the questionnaire survey on problems in labor management. The biggest problem pointed out by many companies is the "lack of skilled workers and technical staff." This corresponds to the results of the questionnaire on the composition of the work force which showed that the number of semi-skilled and unskilled workers is far higher than the number of skilled workers. The main reason for this situation, according to in-depth interviews, may be considered to be the frequent turnover in the Indonesian aluminium industries. Another reason lies in the recent worsening of the labor supply and demand situation in Indonesia due to active recruitment of skilled workers by newly established foreign affiliated companies. There is also a tendency for new graduates to choose service industries such as banking rather than manufacturing industries. This is particularly evident among small and medium-scale companies which face problems in recruiting skillful and promising workers. These matters, taken all together, increase labor costs substantially for most of the companies. As for countermeasures, improvement of the work environment, improvement of employee welfare programs and participation of employees in management through the introduction of TQC circles, are useful activities.

Table 3-3-58: Problems in Labor Management

Problem areas	Number of companies	Ratio
Lack of skilled workers and technical staff	12	60%
Frequent turnover	9	45%
Rapid increase of labor costs	5	25%
High fringe benefit costs	2	10%
Increased training expenses	5	25%
Difficulty in labor negotiations	1	5%
No reply	0	0%

Source: Questionnaire Survey

[3] Training

Training as a part of human resource development can be roughly divided into two categories according to the location of the training. One is in-house and the other is outside training.

As shown in Table 3-3-59, more than 80 percent of the 24 firms surveyed answered that they had some kind of in-house training to improve the production skills of their employees. Nineteen companies out of 20 answered that they regarded OJT as a central part of their in-house training, as shown in Table 3-3-60. It was revealed through in-depth interviews conducted by the Study Team that most in-house training, as represented by OJT, is designed to provide employees with simple technical skills. Few firms have special training programs which include engineering, management or marketing theory.

As shown in Table 3-3-59, 12 out of the 24 companies which responded to the questionnaire use outside training. Of the 12 companies, eight train their employees at overseas training centers, which are considered to be a part of their overseas principal companies, while four train their employees at their foreign capital partner's facilities overseas. In addition to the usual technical support, dependence on foreign companies for training is noticeable. On the other hand, four companies utilize government training opportunities and six utilize private training programs.

Table 3-3-59: Type of Training by Number of Companies

	In-house training		Outside training	
	Number of companies	(%)	Number of companies	(%)
Do	20	(83)	12	(50)
Do not	4	(17)	12	(50)
Total	24	(100)	24	(100)

Source: Questionnaire Survey

Table 3-3-60: Details of Training

In-house training			Outside training		
Training programs	Number of companies (%)		Location of training	Number of companies (%)	
OJT	19	(95)	Private institutes	6	(50)
Own programs	8	(40)	Foreign capital partner's facilities	4	(33)
Others	1	(5)	Overseas institutes	8	(66)
No reply	4	(–)	Public institutes	4	(33)
			Others	2	(17)
			No reply	12	(–)
Total	20	(100)		12	(100)

Source: Questionnaire Survey

[4] Expected government support

As described in Table 3-3-61, 12 companies, or 71 percent of the 17 respondents, expect the Indonesian government to support OJT training carried out by foreign experts. It was determined that the industry strongly desires technology transfer from foreign countries. An increase in technical seminars were requested by five companies. The role of the government in the field of training employees of private companies is relatively small and thus it is expected that the government should play a more important role.

Table 3-3-61: Expected Government Support by Number of Companies

Expected support	Number of companies	(%)
Government support	12	(71)
OJT training by foreign experts	3	(18)
Subsidies for training	5	(29)
Increase in technical seminars	3	(18)
Expansion of public training facilities	3	(18)
Dispatch of instructors from public facilities	7	(–)

Source: Questionnaire Survey

2) Information

[1] Product development information

In general, managers in the aluminium industry have little concern for collecting product development information. It was made clear through observations by the Study Team that few firms among those surveyed had actually conducted any information gathering activities. As shown in Table 3-3-67, managers in the aluminium industry pay less attention to collecting information on product development - it was ranked 12th in the top 20 issues concerning management. Introduction of new technology is considered even less important by mangers, who ranked it 18th. Development of high-value-added products is of greater concern, ranking 8th, but it is still behind such matters as increasing productivity, reducing costs and improving quality. Development of new products through the introduction of new technology from other companies is effective and practical because it takes less time and requires less investment than developing original products and technology.

Most of the aluminium companies surveyed by the Study Team were so consumed with everyday activities such as production and sales that they could not spare time for collecting information, even though many mangers recognized the importance of the activity.

[2] Marketing information

Marketing information covers a wide range of areas including product development, distribution channels, sales prices, sales promotion activities, trends in competing companies and customers, and market trends. Analysis of this information enables companies to plan effective manufacturing and sales activities.

Few of the companies surveyed, with the exception of some foreign-affiliated firms, were active in collecting information on all of the areas mentioned above. Several companies, by introducing simple production control systems run by personal computer, analyzed past sales results, forecast future demand, controlled the purchase of materials and inventory and made future production plans. However, few of them utilized the information for marketing purposes. A major reason for this is that many aluminium products are produced on order ie., production starts after an order is received from a customer. Another major reason is that there are few sources of information in the country and access to the information that exists costs a great deal of money.

In addition, few companies were actively collecting information on overseas markets, mainly because they were not actively exporting. Overseas exhibitions or visits to overseas customers is also considered to be of little concern to managers in the aluminium industry. They are, in many cases, passive in the sense that export sales are the result of overseas buyers visiting them and ordering products rather than they themselves visiting overseas customers. In such cases, information supplied by overseas buyers tends to be limited to such things as product specifications.

As indicated by the questionnaire survey conducted by the Study Team, the results of which are shown in Table 3-3-61, the most popular source of overseas information is through foreign capital partners, followed by overseas agents and buyers, and foreign governmental export promotion organizations in Indonesia. In Indonesia, there is a very limited number of Indonesian governmental organizations which can supply the industry with overseas market information and the available information is often insufficient in both quality and quantity. The questionnaire survey showed that only one company used NAFED, less than the number of companies which used MOI. In terms of necessary information, the status of both competitors and buyers were ranked first. For the promotion of exports from the aluminium industry, easy access to information on overseas markets as well as information on the latest technology and new products is essential. The best way to achieve this may be through the strengthening of governmental organizations.

Table 3-3-62: Sources of Overseas Information

Source	Number of companies	Ratio (%)
NAFED	1	9
MOI	2	18
Foreign trade promotion agencies in Indonesia	3	27
Domestic trading companies	1	9
Foreign capital partners	6	55
Overseas sales agents, buyers	4	36
Others	1	9

Source: Questionnaire survey

Table 3-3-63: Necessary Overseas Market Information

	Number of companies	Ratio (%)
Import trends	5	46
Distribution channels	4	36
Competitors	6	55
Prices	1	9
Business practices	1	9
Laws and regulations	3	27
Buyers	6	55

Source: Questionnaire survey

3) Cost Analysis

[1] Trends in cost factors

In the current survey, data on the elements of the prime cost of manufacture were obtained from one rolling company (coil rolling), three extrusion companies, six utensil, plate work, and impact tube companies, and three die casting and casting companies. The average percents in the prime cost of manufacture for each field of products are shown in Table 3-3-64.

According to this data, raw material costs account for the largest share of the prime cost of manufacture. The percentages, however, differ tremendously according to product, however, being 85.6 percent for the rolling companies, 75.3 percent for the extrusion companies, and only 48.2 percent for the die casting and casting companies. On the other hand, labor costs accounted for a small 4.7 percent of costs for rolling companies and 7.7 percent for extrusion companies, but a high 12.3 percent for die casting and casting companies. This difference is due to the facts that the rolling and extrusion industries are apparatus industries, while the die casting and casting industry is a labor intensive one. Further, the depreciation costs for rolling and extrusion companies are a low 0.1 percent and 4.3 percent, respectively. In particular, the rolling companies are believed to be using machinery and equipment which they have already completely depreciated for their production activities. The depreciation cost for the die casting and casting companies is a relatively high 16.8 percent due to the fact that of the companies surveyed, those manufacturing aluminium wheels for automobiles have recently made large capital investments.

The utensil, plate work, and impact tube companies basically are labor intensive, but there are large differences among them, with labor costs spread from 5 percent to 25 percent. The company with 25 percent labor costs is producing household utensils and has 40 employees. On the other hand, the company with 5 percent labor costs is making plate roofing and has about 20 workers operating the latest machinery. The average depreciation rate for the utensil, plate work, and impact tube companies was 2.4 percent, next lowest after rolling companies and due, it is believed, to the late start in introduction of the latest machinery.

Table 3-3-64: Average Share of Prime Cost of Manufacture by Product Field

	Rolling companies	Extrusion companies	Utensil, plate work and impact tube	Die casting and casting companies
Raw materials	85.6	75.3	70.8	48.2
Labor	4.7	7.7	12.1	12.3
Fuel	3.0	2.6	3.3	2.7
Power	2.2	3.3	2.4	4.7
Water	0.1	1.1	0.2	2.5
Depreciation	0.1	4.3	2.4	16.8
Maintenance	0.6	1.7	3.4	8.8
Others	3.7	4.0	5.4	4.0
Total	100.0 %	100.0 %	100.0 %	100.0 %

Source: Questionaire Survey

[2] Comparison of production costs

Table 3-3-65 compares the average production costs for aluminium products in Indonesia and Japan by product field. Japanese data are for small and medium-scale companies and were compiled by the Agency for Small and Medium-Scale Industries in Japan. Although there are some differences between the Japanese and Indonesian data in terms of the product items covered by each product field, based on the table, the aluminium industry in Indonesia, in comparison with Japan, can be described as follows:

(a) The cost of material for rolled and extruded products, household utensils and plate processed products in Indonesia is almost the same as in Japan, while the cost of diecasting products in Indonesia is about 17 percent less than in Japan, accounting for less than 50 percent of total production costs. This does not simply mean that the Indonesian companies can purchase low cost aluminium alloys. It may be due to high depreciation costs resulting from some companies' recent introduction of expensive production facilities from abroad, a move which has subsequently reduced the relative ratio of raw material costs. On the other hand, the material costs for rolled products in Indonesia is high. The biggest reason is that some of the virgin ingot is imported and, until very recently, a 20 percent import duty had been imposed on imported ingot. This duty no longer exists, and thus it is thought that the raw material costs for rolled products have gone down.

(b) With the exception of household utensils and plate processed products, the ratio of labor cost is small, reflecting the fact that the average labor cost per person in Indonesia is about one tenth that in Japan. The cheap labor cost, however, is not adequately reflected in the prices of final products as all of the firm's are small and their production efficiency is low. On the other hand, production of household utensils and plate processed products is the most labor intensive field in the aluminium industry in Indonesia and production is heavily dependent on manual work which pushes labor costs higher compared with other product fields.

(c) Although the rate is not shown in the table, the ratio of subcontracting is very small. In Japan, due to a well-developed division of labor, the rate of subcontracting is relatively high, at 3.1 percent for rolled and extruded products, 16.4 percent for household utensils, and 21.7 percent for diecasting products. On the contrary, in Indonesia, aluminium companies perform most of the processing work from raw materials to finished products at their own factories. This situation is a result of the underdeveloped state of the supporting industries which would undertake subcontracting.

(d) Depreciation costs are high for rolled products and small for diecasting products. The major machines used at most of the rolling companies in Indonesia are pull-over machines which are considered to have been completely depreciated. Coil rolling machines, with the exception of a few newly purchased ones, are also old and almost fully depreciated. These old machines would help reduce the cost of production because of the minimal depreciation costs involved, but they are outdated and the resulting low productivity, lack of accuracy and lack of reliability, make them unsuitable for production of high quality products. It is necessary, therefore, to replace the old and outdated machines with new ones. Since low pressure casting companies have recently invested in new large-scale facilities, casting firms' depreciation costs have increased substantially. With the latest production facilities, the low pressure casting companies have succeeded in producing and exporting high quality products to such advanced countries as Japan.

Table 3-3-65: Comparison of Production Costs of Aluminium Products

Unit:%

Cost Element	Rolling		Extrusion		Utensil, plate work, etc.		Diecasting, etc.	
	Japan	Indonesia	Japan	Indonesia	Japan	Indonesia	Japan	Indonesia
Raw materials	76.6	85.6	76.6	75.3	85.3	70.8	64.9	48.2
Labor	12.7	4.7	12.7	7.7	8.6	12.1	22.7	12.3
Fuel	0.2	3.0	0.2	2.6	0.1	3.3	0.7	2.7
Power	1.7	2.2	1.7	3.3	0.6	2.4	1.6	4.7
Water	0.0	0.1	0.0	1.1	0.0	0.2	0.1	2.5
Depreciation	4.1	0.1	4.1	4.3	1.4	2.4	3.7	16.8
Maintenance	1.6	0.6	1.6	1.7	0.5	3.4	0.8	8.8
Others	3.1	3.7	3.1	4.0	3.5	5.4	5.5	4.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Questionnaire Survey; Cost Analysis of Small and Medium Size Industries, 1989

[3] Cost reduction activities

The biggest cost factor in the production of aluminium products is materials. Aluminium ingot and aluminium alloys are both produced in Indonesia. However, most ingot and alloys consumed in Indonesia, particularly the alloys, are imported from abroad because of quality problems with domestic products. Although the base prices of imported alloys may be almost the same as their domestic counterparts, the final purchase prices are often greater due to various import-related costs such as transportation costs, import handling fees and insurance. This causes an increase in total production costs. In addition to the costs of imported materials, electricity costs and low production yields were mentioned by many of the companies surveyed as factors affecting total production costs. Other factors affecting costs include inflation and interest rates. In recent years, the inflation rate in Indonesia has been high and the interest rates of commercial banks have remained at a high level. These problems cannot necessarily be resolved through the efforts of individual companies since they are more related to Indonesian constitutional problems.

Each firm recognizes the need to streamline the production process but this cannot be done immediately. Fifteen of the surveyed companies pointed out the procurement of lower cost materials as a countermeasure to be taken. Direct purchase of materials was cited by 10 companies. Fewer companies recognized the need to improve technology levels, improve productivity and increase in-house production of materials. Although a positive attitude toward the cutting of material costs appears to be widespread, improvement of technology levels and productivity as well as long-term R&D activities are essential for the industry's development. Government support for R&D activities would be requested. The results of the questionnaire survey are shown in Table 3-3-66.

Table 3-3-66: Cost Saving Activities

	Number of Companies	Ratio (%)
Improve Productivity	6	32
Improve Technology Level	9	47
Procure Lower Cost Materials	15	79
Direct Purchase of Materials	10	53
Increase In-house Production of Materials	2	11
Others	0	0

Source: Questionnaire Survey

4) Attitudes of Management

Table 3-3-67 shows the results of a questionnaire survey on issues which concern managers. The following table shows the five items of most concern to managers and the percentage of managers citing each item for comparison. Based on the results shown in the table and the results of interviews, the following can be said:

[1] The main item of concern to aluminium companies at the moment is increasing productivity, an issue chosen by two thirds of the managers surveyed. Tied for second place are reducing costs and procuring cheaper materials. Managers are seeking better quality and less expensive materials to reduce costs while trying to increase productivity at the same time.

[2] Next on the minds of managers - those items ranked from fourth to sixth place - are issues related to improving quality, strengthening marketing, securing funds, and modernizing production facilities. Compared with items ranked first to third, these items involve long-term measures and interrelated, requiring simultaneous efforts in all areas. The managers' strong concern regarding financing may be the result of the difficulty small and medium-scale companies experience in trying to borrow money from banks.

[3] Concern regarding employee training is moderate, ranking eighth. Education and training of workers is a basic part of management, and, in the long-run, it will determine the success of companies. Many managers realize this but pay less attention to the issue than they do to short-term concerns.

[4] The managers showed moderate interest in developing high-value-added products and show little interest in introducing new technology, expanding R&D activities or collecting technical information, all of which are key factors for the development of high-value-added products. In general, the managers put much higher priority on the improvement of present operations than on investment for the future. Consequently, they do not show strong concern for R&D activities, which take a long time to produce concrete results.

[5] Both collection of overseas marketing information and expansion of exports are of less concern to managers, ranking 8th and 12th, respectively. While a similar item, strengthening of marketing, was ranked fifth, concern for these two items is considered to be very low. The immediate concern of the managers is to increase sales in Indonesia. They are not prepared to export because they have limited knowledge in this area.

[6] Concern regarding the utilization of governmental incentives was particularly low - no managers chose this issue. One of the major reasons is that there are few incentive programs which are attractive to the industry. Another reason is that the procedures for applying for such incentives are complex and time consuming. Many of the managers

with whom the Study Team conducted in-depth interviews hoped the government would lift import duties on aluminium materials rather than create new incentives.

Table 3-3-67: Main Items of Concern by Managers

Rank	Number of Companies (%)	Items of Concern
1	67	Increasing productivity
2	58	Reducing cost
	58	Procuring cheaper materials
4	46	Improving quality
5	42	Strengthening marketing
6	29	Securing funds
	29	Modernizing production facilities
8	21	Training workers
	21	Shortening delivery period
	21	Developing high value-added products
	21	Collecting overseas marketing information
12	17	Expanding production
	17	Expanding exports
	17	Collecting technical information
15	13	Recruiting good workers
	13	Utilization of domestically-produced materials
	13	Expanding R&D activities
18	8	Introducing new technology
19	0	Utilizing export incentives
	0	Others

Source: Questionnaire Survey

(3) Supporting Industries and Facilities

1) Supporting Industries

[1] Material Industries

Aluminium raw material is roughly divided into two types. One is pure aluminium, or virgin ingot, and the other is aluminium alloys which contain various chemical elements to improve the characteristics of the aluminium to meet specific purposes.

In Indonesia, P.T. INALUM is the lone producer of virgin ingot. Purity standards for the ingot are 99.9% for high purity type and 99.7% for standard type. The quality meets international standards, and virtually no complaints about quality have been made by consumers. Some of the virgin ingot consumed in the country is imported, mainly from Australia, and quality problems rarely occur.

With alloys, because of quality problems, imported ones are in widespread use. Australia and Japan are the major exporters of alloys to Indonesia. According to interviews with large consumers of alloys, the chemical compositions of Indonesian alloys tend to fluctuate. These consumers believe that chemical composition inspection machinery at alloy manufacturers does not receive proper maintenance, including periodical calibration with standard machines. In addition to quality problems, consumers also mentioned delays in delivery when dealing with domestic alloy manufacturers.

In Japan, aluminium scrap is an important material which accounts for approximately one-third of all the aluminium material used in the country. Although there are no reliable statistics, the use of aluminium scrap in Indonesia is estimated to be low. Some of the major reasons are the small volume of usable aluminium scrap due to the small production of aluminium products, delayed application of aluminium to drinking cans, which are easily recycled, and difficulty in establishing a nation-wide recycling system because of Indonesia's sprawling geography. Almost all of the aluminium companies, use in-house scrap as a material, mixing it with new material to produce aluminium products. Generally speaking, there is little chance of in-house scrap causing quality problems. However, at some companies, control of in-house scrap is so inadequate that impure materials are often mixed in. This situation, combined with an insufficient inspection system, turns out poor quality products. In the long term, establishment of an effective system of collecting aluminium scrap is necessary. Meanwhile, strict control of aluminium scrap should be implemented at each factory immediately.

[2] Die industry

There are few companies which produce diecasting dies in Indonesia. Only two companies were identified through the current survey. Both companies have several technical problems. Some of the problems include rough die surfaces, insufficient surface hardness stemming from insufficient heat treatment and short die life resulting from poor design.

Among governmental or semi-governmental institutions, the Swiss Polytechnic for Mechanics (Politeknik Mekanik Swiss) and IDMMI, both in Bandung, have production facilities for dies. However, both have limited experience in producing diecasting dies. The former has expertise in press dies, but it has so far produced only simple diecasting dies. The latter has also limited itself to simple diecasting dies such as those used for chair parts. The overall accumulation of technology and know-how in the area of dies is still very small in Indonesia.

As discussed above, the die industry in Indonesia, which should support the aluminium casting industry, is still developing and can respond to the requirements of the aluminium industry only for a limited number of simple dies. Most of the die users in the country are in the transportation industry, and, according to the current survey, no companies use domestic dies. Instead, they use imported ones supplied mainly by their overseas principal companies. Japan is by far the largest supplier of these dies. Some companies import dies from Taiwan and Singapore. Production of dies for permanent mold casting is technically much easier than producing dies for diecasting and some domestic companies produce mold casting dies in-house.

2) Supporting Facilities

[1] Technical Support Institutions

There are 18 institutes in Indonesia which conduct various activities in R&D, and testing and inspection of materials under the authority of BPPI of MOI. These include nine central R&D institutes and nine regional testing and inspection laboratories. Among them, the central R&D institutes which provide technical support to the aluminium industry are the Institute for R&D of Industrial Materials and Technical Products (IRDMTP) and the Institute for Development and Metal and Machinery Industries (IDMMI). These two institutes are described as follows:

(a) Institute for R&D of Industrial Materials and Technical Products (IRDMTP)

IRDMTP was originally established as a metal testing laboratory in Jakarta in 1909. It was moved to Bandung in 1920 and re-established as a materials testing laboratory. After the expansion of its facilities, it became the present IRDMTP in 1980. Approximately 250 employees are engaged in administration and the following five divisions: construction materials, organic chemistry, inorganic chemistry, metal and technical products. IRDMTP conducts various activities in these areas as follows:

a) Testing and inspection
- — All kinds of material tests (strength, non-destructive, corrosion, microstructure, chemical and physical properties)
- — Calibration testing of measuring equipment

b) Inspection and quality assurance
- — Non-destructive tests of plant equipment, ships and machinery, and issuance of official inspection certificates

c) Training of engineers
- — Quality control, welding, NDT inspection, concrete technology, microwave inspection

d) Corrosion and pollution control
- — Quality tests of waste water, corrosion protection for equipment

(b) Institute for Development of Metal and Machinery Industries (IDMMI)

IDMMI was established under the authority of MOI in Bandung in 1969. Belgium began technical assistance including the sending of experts and the donation of necessary facilities in 1970 and this assistance has continued to date. The institute's objective is to offer technical assistance mainly to small to medium-scale metalworking industries. It conducts R&D activities in conjunction with industries in the fields of industrial materials, production processes, jigs and fixtures, and development of new products, etc. Its major activities are summarized as follows:

a) Improvement of technology
- — Improvement of production technology
- — Research on industrial materials
- — Development of new products

b) Technical assistance
- — Various assistance to small to medium-scale metal industries

c) Education and training
- — Sponsorship of training programs, seminars and exhibitions
- — Workshops (machine processing, casting, sheetworking, heat treatment)

(c) Testing and inspection facilities

Among major testing and inspection facilities owned by IRDMTP and IDMMI, those concerning the aluminium industry are as follows:

a) IRDMTP

Field	Equipment	Unit	Year of Purchase
NDT Inspection	Control Box	1	1982
	Camera Container	2	1975
	Survey Meter 0-1000m R/H	1	1982
	Ultrasonic Flow Detector	1	1975
	Magnetic Particle	1	1975
	Crack Depth Meter	2	1975
Sample Piece Making	Saw Machine	1	1955
	Circular Saw Machine	1	1981
	Planer Machine	1	1976
	Drilling Machine	1	1976
	Grinding Machine	2	1972
	Tool Grinding Machine	1	1950
	Oxygen Cutting Machine	1	1982
Destructive Inspection	Universal Testing Machine 300t	1	1912
	Universal Testing Machine 100t	1	1980
	Universal Testing Machine 50t	1	1912
	Universal Testing Machine 20t	1	1912
	Universal Testing Machine 5t	1	1912
	Wire Torsion Testing Machine	1	1912
	X-Y Recorder with Electric Extensometer	1	1917
	Dividing Machine for Test Bar	1	1979
	Micro Hardness Tester	1	1974
	Rockwell Hardness Tester	1	1979
	Universal Hardness Tester	1	1975
Metallurgy	Specimen Preparation Equipment	2	1970
	Microscope	1	1970
	Metallurgical Microscope 5-1500X	2	1972
	Box Furnace 1000°C	1	1980
	Specimen Mount Press	1	1983
Corrosion Test	Potensiostat and Electrode	1	1978
	Salt Spray	1	1972
	Humidity Test	1	1973
	Gas Corrosion	1	1973
	Multi Combination Meter	1	1973
Inorganic Inspection	Carbon and Sulphur Determination on Steel	1	1977
	Electrodeposit Analyser	1	1980
	Electric Furnace	1	1972
	Flame Photometer	1	1978
	Spectrophotometer	1	1979
	Nitrogen Determining	1	1979
	Emission Spectrometer	1	1982
	Infra-red Spectrometer	1	1978
	Gas Chromatography	1	1972
	Oven	1	1980

ii) IDMMI

Field	Equipment	Unit
Metallurgy	Abrasion Grinder	1
	Polishing Machine	3
	Water Still	1
	Orate Analysis Gas	1
	Magnetic Stirrer	1
	Heater/Cook Plate	2
	C.S. Stochlein	1
	Heating Furnace	1
	Drying Oven	1
	Balance	1
	Microscope Metapan	1
	Hardness Tester	1
	Nitrogen Apparatus	1
	Hardness Tester	1
	Electrolyseur	2
	Electro Analysis Apparatus	1

(d) Functional limitations of existing institutes

Although there are two institutes, IRDMTP and IDMMI, concerned with the aluminium industry, as stated earlier, they have the following functional limitations.

a) They conduct various types of research on production technology and R&D in various fields of metallurgy, but their activities in the area of aluminium casting are very limited.

b) They carry out transfer of technology to small to medium-scale metalworking companies. The number of companies which receive such assistance, however, is very small due to limited manpower and budget.

c) Precise machining is a key factor in the production of dies. Neither institute is equipped with sufficient facilities for technological development in the field. Facilities for precise machining as well as accurate inspection are necessary.

d) They do not have inspection equipment or instruments for overall judgement of performance of metalworking products. These machines are useful since many of the casting products are used as parts in motorcycles and automobiles.

e) Both institutes are equipped with limited facilities for heat treatment, plating and precision machining. These are the machines necessary for die making and surface treatment of extruded products.

f) Judging from the present manpower and existing facilities, it would be difficult for the existing institutes to provide quick and effective technical assistance to the aluminium industry.

[2] Human resources development

While universities emphasize theory more than practice, at polytechnics more emphasis is put on practical work which is intended to produce middle level engineers. Nineteen polytechnics have been established throughout Indonesia, but none are directly related to aluminium. The Swiss Polytechnic for Mechanics (Politeknik Mekanik Swiss) is for mechanical engineering and covers aluminium to some extent. Details of the school and its activities are as follows:

(a) This institute was the first polytechnic in Indonesia, established in 1975 with the assistance of the Swiss government. The capacity of the institute is 104 students for each grade, or 312 students in all. The institute offers training courses for industries and at present about 160 trainees are receiving training.

The institute comprises a mechanical training workshop, a modern toolmaking workshop, a drawing and design school, and a foundry school. Seventy percent of the training involves the actual operation of machine tools in workshops and the remaining 30 percent involves classroom work.

(b) Facilities

More than 100 various machine tools, including the latest ones such as CNC milling machines and electrical discharge machines, 165 workbenches and 50 drafting boards with precision drawing machines are provided. The institute has the only foundry facility among polytechnics in Indonesia. However, facilities for production or testing and inspection of diecasting are very limited.

(c) Assistance to industries

The policy of the institute is not only to educate students but also to provide industries with various technical services. The institute offers industries a 40 hour-per-week training package, which includes such subjects as operation of machine tools and technical drawing. In addition, the following technical services are rendered to industries for a fee:

— Technical consulting on foundry operation
— Technical consulting on metal processing
— Designing and production of molds
— Designing and production of press dies
— Designing and production of metal dies
— Precision machining of metals
— Rehabilitation of machine tools