i. Other equipments

Few of other measuring equipments are owned by enterprises.

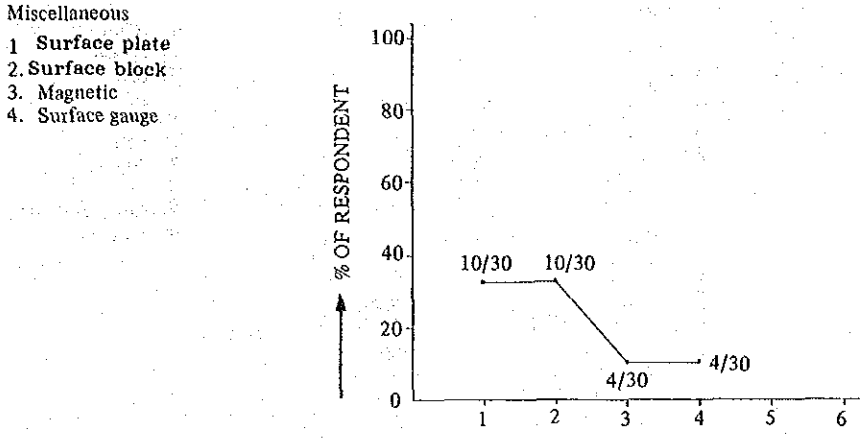


Fig. 4.4.6-17

j. Summary of measuring, testing equipment

Examinations of measuring and testing equipments from item a to i showed that very few equipment owned by enterprises. Expensive equipment may be difficult to be equipped for small enterprises, but simple and low-priced equipment should be equipped. It also shows that instruction and aid are urgently necessary especially for measuring inspection.

5) Trends of Standard and/or Specifications (Fig. 4.4.6-18 (Q44))

JIS 53% (16/30), Customer's standard 63% (19/30) are mostly utilized. As in the case of measurement tool, actual conditions being performed must be correctly comprehended. Instruction and aid by public institution are greatly required for enforcement of Industrial Standard.

6) Cost for research and development (Fig. 4.4.6-19 (Q45-01))

70% of enterprises (21/30) spends for research and development less than 1% of sales, and 43% spends none.

It is noticeable that 20% of enterprises (6/30) spend more than 3%. Aid by public institution is needed. Table 4.4.6-8 (Q-74) shows that enterprises are also expecting.

Q44 What kind of industrial standards do you use? (S/A)

Tick the first box for owned standards and insert Δ into the second box for ones actually in use.

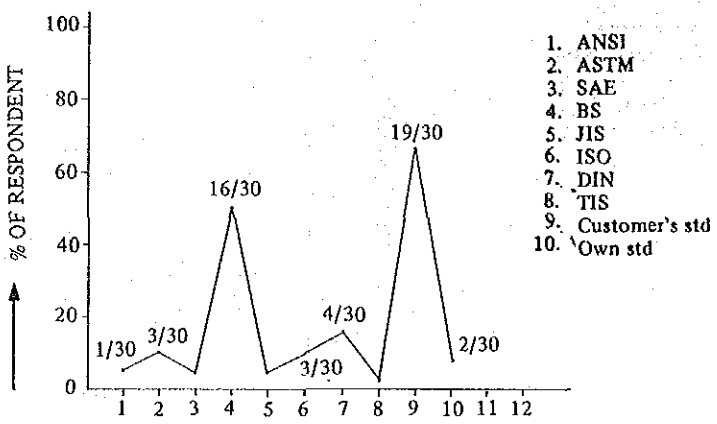


Fig. 4.4.6-18

Q45-1 How much to the sales do you spend on research and development? (S)

1. None
2. Less than 0.5%
3. 0.5%–1%
4. 1.1%–2%
5. 2.1%–3%
6. More than 3%

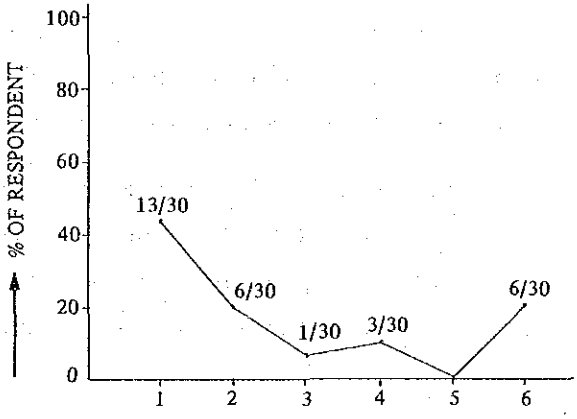


Fig. 4.4.6-19

7) Quality Control System

Defective rate after shipping is high. 66% of enterprises (20/30) have a defective rate of more than 2%. Among them, 20% of enterprises (6/30) have more than 5%. It shows problems exist in quality control system. Exact comprehension of actual situation is needed, but instruction and aid by public institution is also required because those concerned should be trained.

a. Inspection system (Fig. 4.4.6-20)

19/30 of enterprises conduct total inspection. Most enterprises seem to be conducting inspection. But due to high defective rate after shipping, inspection, system must be rechecked to systematically improve defective rate.

Q46-1 Please give informations on your quality control system, i.e. the inspection systems, checking items and the feed back system. (M)

The inspection system is

1. Systematic inspections are not available, "When trouble occurs check"
2. First articles inspection
3. Single sampling inspection
4. Multiple sampling inspection
5. Sequantial sampling inspection
6. Total (100%) inspection
7. Without acceptance or purchasing inspection
8. With acceptance or purchasing inspection by standard inspection documents

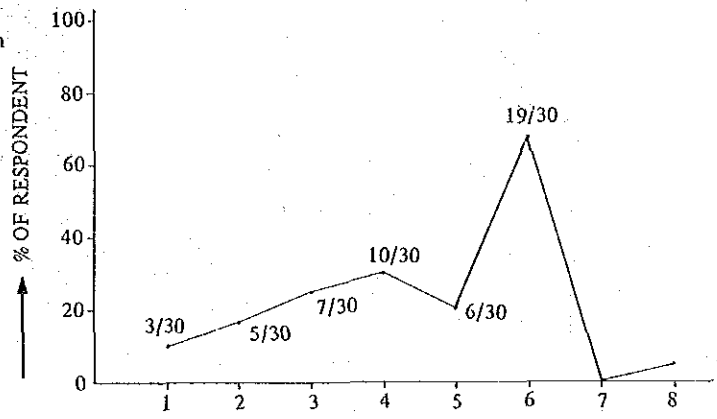


Fig. 4.4.6-20

b. Inspectors (Fig. 4.4.6-21 (Q46-01-01))

Inspection may be conducted by manager of owner, worker and staff, but it is necessary to be rechecked whether it is completely conducted.

Whom is it inspected by:

1. Workers themselves
2. Manager or the owner
3. Professional staff patrol
4. Professional staff stationary

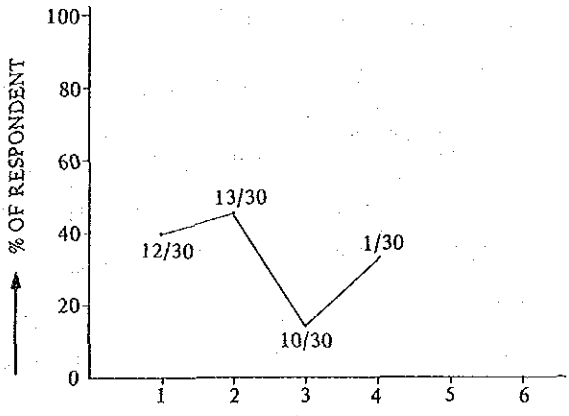


Fig. 4.4.6-21

c. Checking methods (Fig. 4.4.6-27 (Q46-01-01))

Visual check and Dimentional check are most frequently conducted, but other high degree inspections are few.

Useful inspection should be conducted according to defective rate.

Fig. 4.4.6-26

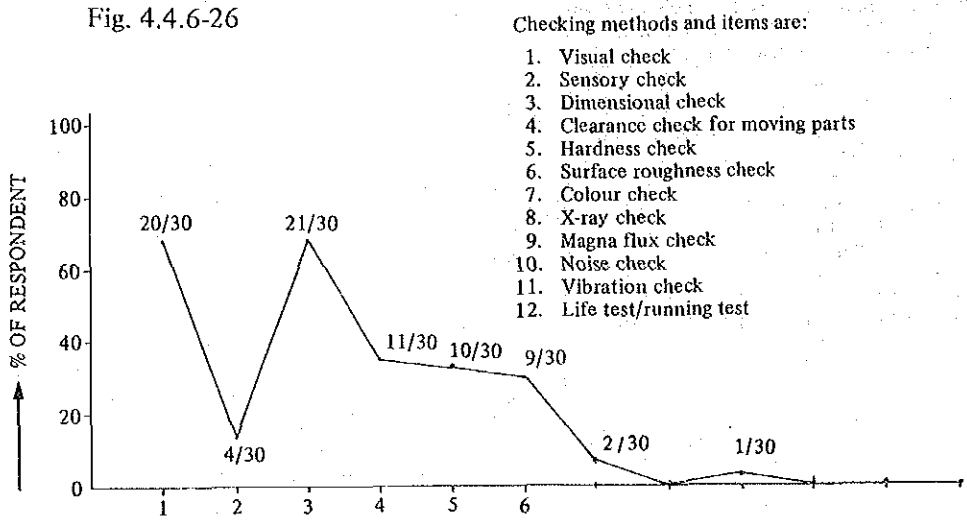


Fig. 4.4.6-22

d. Feedback method (Fig. 4.4.6-23 (Q46-01-01))

Make sure to check that Establishing counter measure (7/30 + 3/30) is surely performed. Establish counter measure must be systematically conducted. Feedback system must be rechecked to decrease defective rate, and those concerned with QC must be trained. Aid by public institution is needed.

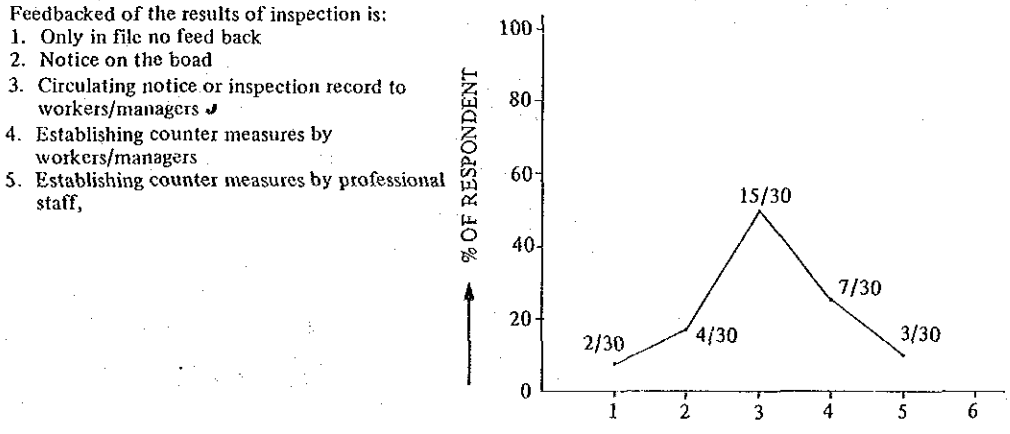


Fig. 4.4.6-23

8) Standardization Level (Fig. 4.4.6-24 (Q49-01-01))

Items of standardization can be listed in order of frequency as, Production/works 20/29, Quality control 17/29, Inspection/Testing 16/29, Process 15/29 and Design 11/29. Costing, Measuring, Transportation After service and Trouble shooting have some problems, to be solved in the future.

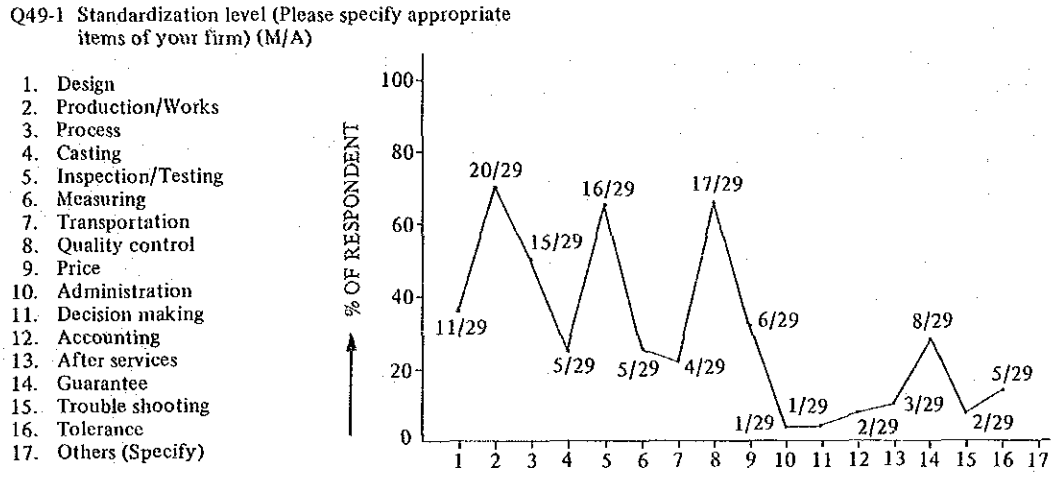


Fig. 4.4.6-24

9) Sources of Technical Information and/or Knowhow (Fig. 4.4.6-25 (Q49-04-01))

Subcontractor (11/30), Other firms (11/30), Magazine (10/30), Seminar (10/30), Workshop (10/30) and Human network (10/30) are the main source of technical information. Extention office, Circular, Industrial service institute, University/College and Exhibition are few. Active service by public institution is desired.

Table 4.4.6-8 (Q-74) shows that enterprises are expecting it.

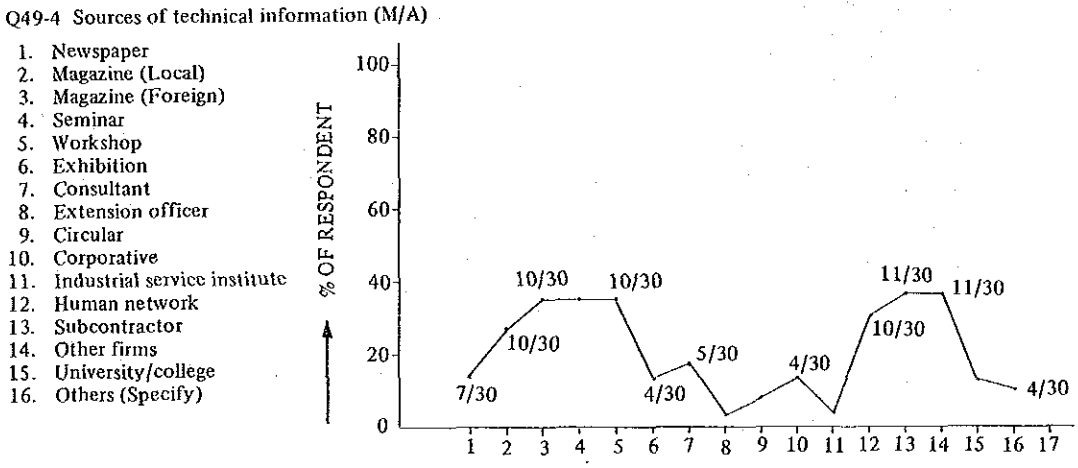


Fig. 4.4.6-25

10) Shipment Inspection (Fig. 4.4.6-26 (Q49-07))

Checking by the staff of subcontractor is being conducted in 18/29 of companies. But due to high defective rate, enterprises must consider what to do. Instruction and trainning by public institution are also needed.

Q49-7 Shipping inspection system (For subcontracted goods) (S/A)

1. None
2. Permanent check by subcontractor's staff before delivery
3. Temporary check by subcontractor's staff before delivery
4. Visual check after delivery
5. Inspection records check after delivery
6. Self-management of subcontractee
7. Others (Specify)

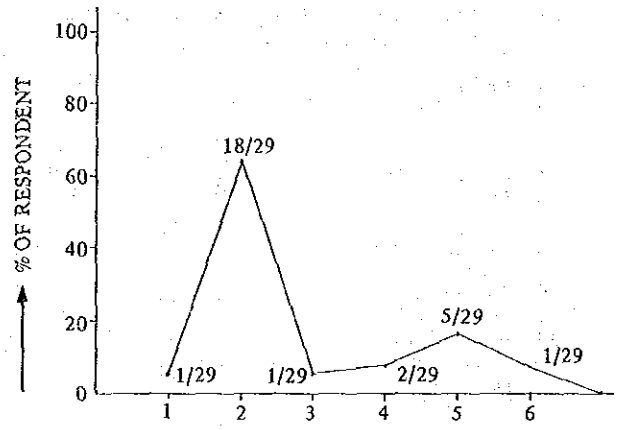


Fig. 4.4.6-26 Q49-07)

11) Inspection Records (Fig. 4.4.6-27 Q49-08))

Dimension check records by 18/29, Visual Inspection records by 17/29, and Material test records by 12/29 are conducted in many companies, but not enough. Conduct of Statical operation test records by 7/29, and non-destructive test are few. Conduct of chemical component analysis and heat treatment records are also few. Nothing is by 4/29.

Q49-8 Inspection records (M/A)

1. Nothing
2. Visual inspection records
3. Dimension check records
4. Colour check records
5. X-ray, ultrasonic magna flux test records
6. Material test records
7. Material analysis records
8. Heat treatment records
9. Statical operation test records
10. Dynamical operation test records
11. Others (Specify)

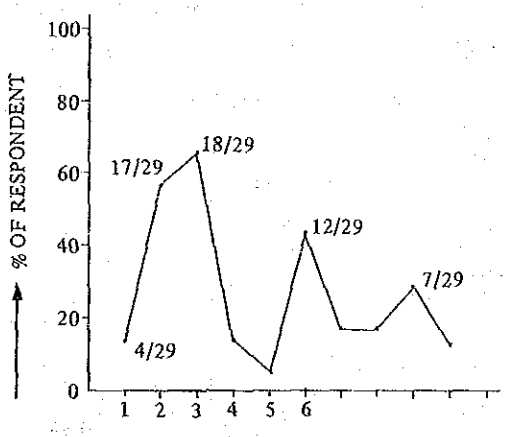


Fig. 4.4.6-27

As shown in item 4 of measuring inspection, insufficiency of measuring and inspection equipment result in less inspection report. Instruction and aid by public institution is desired.

12) Defective Rate (Fig. 4.4.6-28 (Q49-09))

66% of enterprises (20/30 companies) have a defective rate after shipment of more than 2%, and among them 20% (6/30) have more than 5%. Companies with less than 1% of percentage defective is one-third (10/30). Quality control system, including measuring inspection, is generally required to be rechecked. Reflection of the enterprises, and the instruction and aid, such as education and training of employee, are essential. Emphasis should be placed on because these enterprises are automobile-related industries.

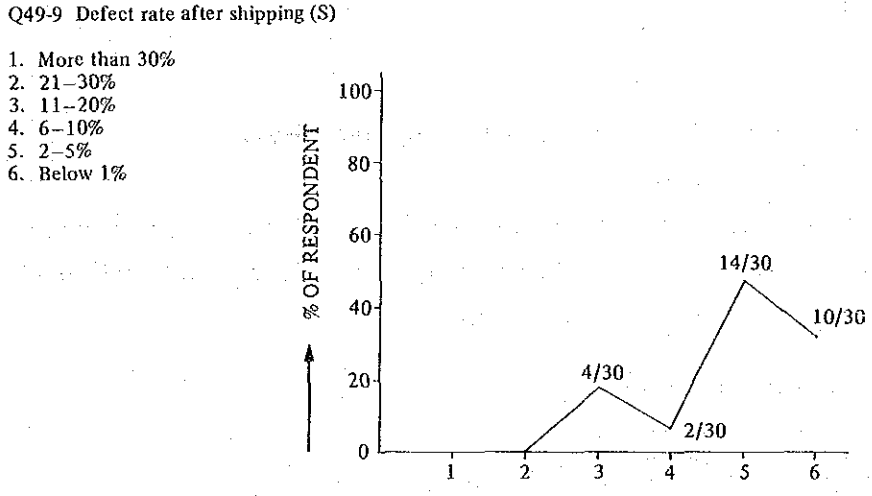


Fig. 4.4.6-28 (Q49-09)

13) Defectine Control (Fig. 4.4.6-29 (Q49-10))

Examination of defects is conducted by total analisis (13/29 companies) and empirically (3/29). 6/29 of enterprises conduct every product or every process, and only 1/29 conduct both. Education and training of employee are needed, and instruction and aid by public institution are desired.

Q49-10 Defect management system (S/A)

1. Not applicable
2. Emprically
3. Analysis of causes as a whole
4. 1. + their monetary terms conversion
5. 4. either for each kind of product or process
6. 4. both for each kind of product & process
7. Others (Specify)

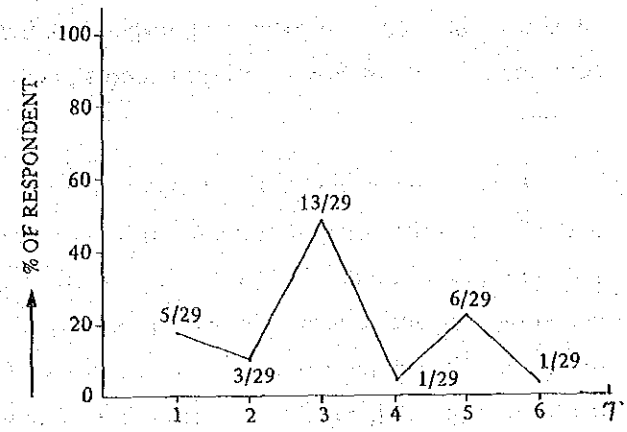


Fig. 4.4.6- 29

14) Enterprise s Technical Levels Evaluated through Interviewer

(Fig. 4.4.6- 30 Q 49-13))

About 60% of the enterprises (17/29 companies) have local level, and improving to National level is desired. As automobile parts industry is one of the main industry in Thailand, the role of public institution is important for it.

Q49-13 Interviewer's assessment of technical level (S)

1. Very low (Primitive level)
2. Relatively low (Traditional level)
3. Normal/Average (Local level)
4. Relatively high (National level)
5. High (International level)
6. Extremely (Exportable level)

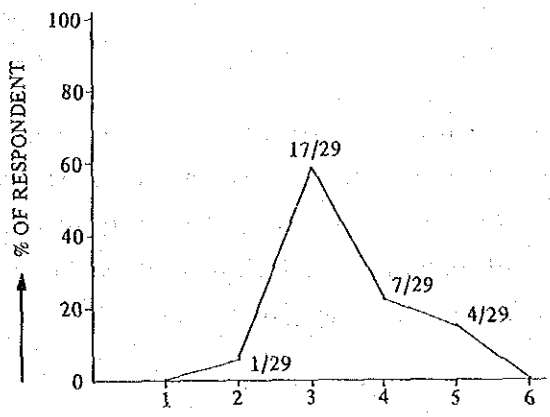


Fig. 4.4.6-30

(3) Raw Materials (Fig. 4.4.6-31 (Q-50-01))

About 60% of enterprises (15/26 companies) never buy used parts. 1/26 companies or 2/26 of them buy gears, bearings, bushes, motors and others in used condition. And they purchase these automobile parts as their raw materials.

Raw materials for automobile parts are mostly imported, some of the imported ones are semi-finished parts. Small scale production will invite the higher production cost than that of imported parts, however, increasing demand and advancing standardization of the parts will help to decrease the production cost, moreover, will compete with the imported goods.

Some of automobile parts made by casting and forging are domestic ones, or some of imported. Raw materials for forging are also imported as bars or billets.

In future, it is enthusiastically expected to acheive technical improvement in order to produce domestically the majority of the automobile parts, and education and training of these engineers and mechanics should be positively promoted, on the other hand, it is necessary for the government or the public organization to guide and assist the education and training so that the quality level of the parts meet the international specifications.

Q50-1 What do you purchase used or second hand parts and raw materials such as gears, bearings, motors etc. as key components of your products? (M/A)

1. None
2. Gears
3. Bearings
4. Bushes
5. Motors
6. Steel
7. Raw materials
8. Others (Specify)

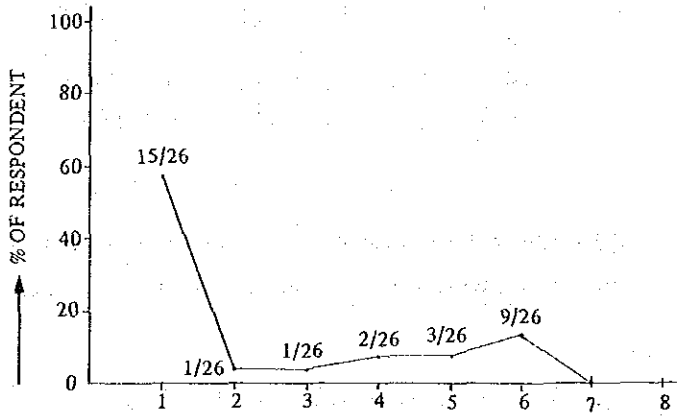


Fig. 4.4.6-31

(4) Market, Demand and Prices

1) Market Area (Fig. 4.4.6-32 (Q20-01))

For domestic market, there are many as 23 of 30 total enterprises. For the local, there are many, also. However, there are only a few for developing countries, NICs and developed countries.

Domestic: 80%, Export: 20%

Q20 Where are your products sold and consumed? (M)

1. Region/District
2. Province/State
3. Country
4. Developing countries
5. Newly industrialized countries (NICS)
6. Developed countries

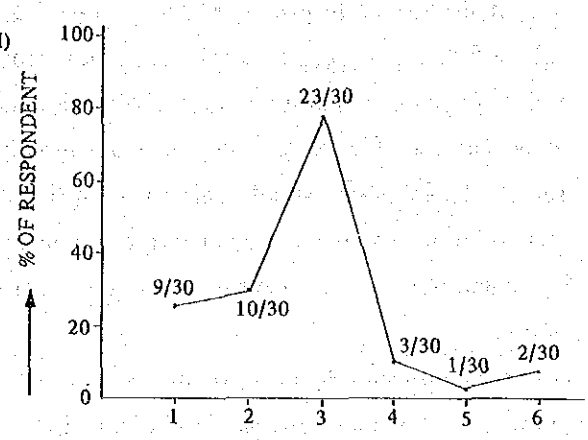


Fig. 4.4.6-32

Export and Import of Automobile parts

Import amount of automobile parts used for assembly production (A) and for using cars (B) in Thailand. (from Thailand Customs House Data)

Table 4.4.6-6 Unit: Million ฿

	Import (C.I.F.)		Export (F.O.B.)
	(A)	(B)	
1974	1648.21	473.43	14.54
1975	1791.08	525.04	12.52
1976	2687.56	631.92	23.10
1977	4652.22	805.91	40.87

Automobile parts industry has a possibility to develop into a great industry in Thailand, provided it will be a home-made industry in future.

2) Back Orders (Fig. 4.4.6-33 (Q22-01))

Enterprises which have back orders of one month or more hold 40% (12/30 companies), 60% (18/30) of rest have less than one month production.

Q22-1 How much of production orders do you have in hand? (S)

1. None
2. One week or less
3. 8–15 days
4. 16–30 days
5. 1–5 months
6. More than 5 months

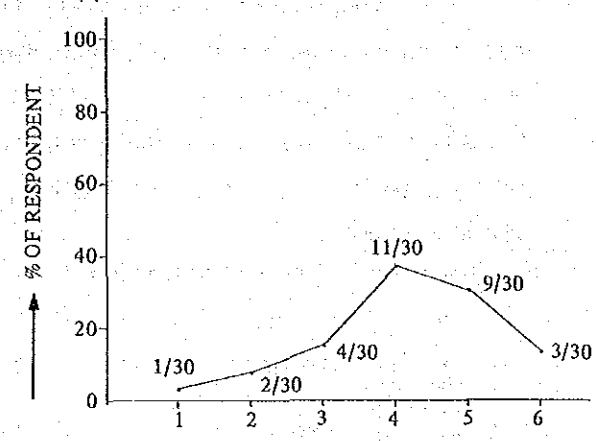


Fig. 4.4.6-33

3) Price Competitiveness (Fig. 4.4.6-34 (Q24) & Fig. 4.4.6-35 (Q28))

Approximately about 60% of the enterprises are competitive with the market prices, less competitive enterprises cover about 40%.

Q24 Assessment of price: Price level (s)

1. 31% and above higher
2. 21%–30% higher
3. 11%–20% higher
4. 1%–10% higher
5. Market price
6. Less than market price

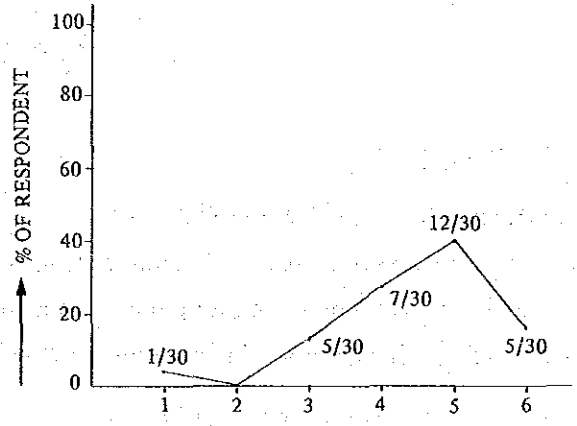


Fig. 4.4.6-34

Competitive Power in the Market.

Most of them are moderate, more competitive ones (self-recognized as "strong") are 33%.

Q28 What is the present position of the firm in its own market?
How does it compare with its competitors? (S)

1. Very strong
2. Strong
3. Moderate
4. Weak
5. Very weak

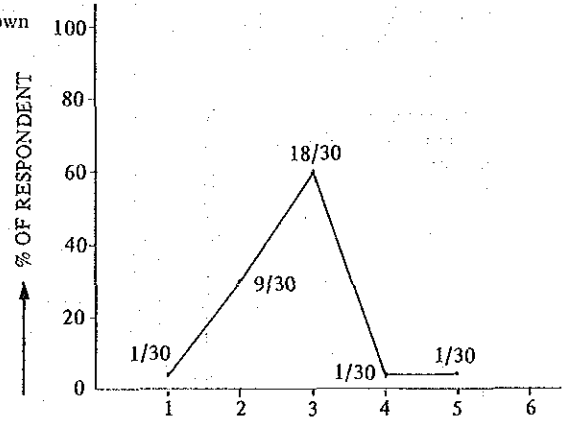


Fig. 4.4.6-35

4) Cost Management (Fig. 4.4.6-36 (Q23-01))

Labor management expenses (21/30 companies), material management expences (18/30), general administrative expences (15/30) and administrative expences of each product (12/30) are fairly managed by many companies.

Few companies are taking sales charge, profit calculation and depreciation into their consideration.

Q23 Break down of Costing/Accounting System (M/A)

1. None
2. Every kinds of products
3. Every kinds of parts and compertments
4. Material cost
5. Labour cost
6. Direct cost/indirect cost
7. Overhead
8. Sales charge
9. Profit
10. Depreciation
11. Fixed cost
12. Variable cost
13. Others (Specify)

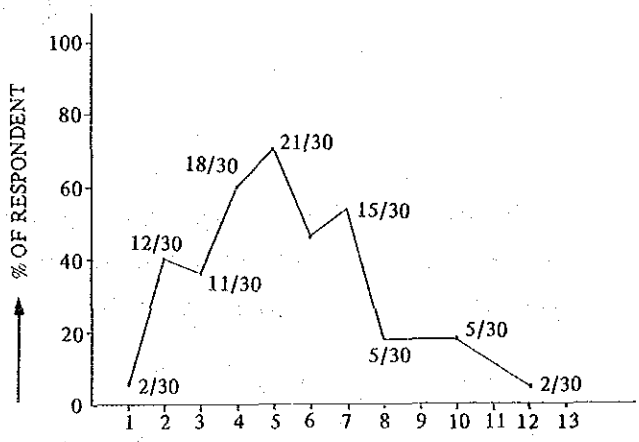


Fig. 4.4.6-36

5) Market Survey (Fig. 4.4.6-37 (Q-29))

The enterprises who survey their competitors, selling prices and quality are about 30–60%. However, technology state of the art, subcontract survey and demand prospect are not well achieved. Therefore, information assistance of public organization is required.

Q29 Have you ever marketed directly or indirectly the products, if so what and how? (M)

Market tendency

1. Competitors
2. Seiling prices
3. Purchasing prices
   new materials
   key parts/component
4. Quality
5. Subcontractors
6. New technology

Demand situation

7. Total demand
8. Domestic output/export
9. Import

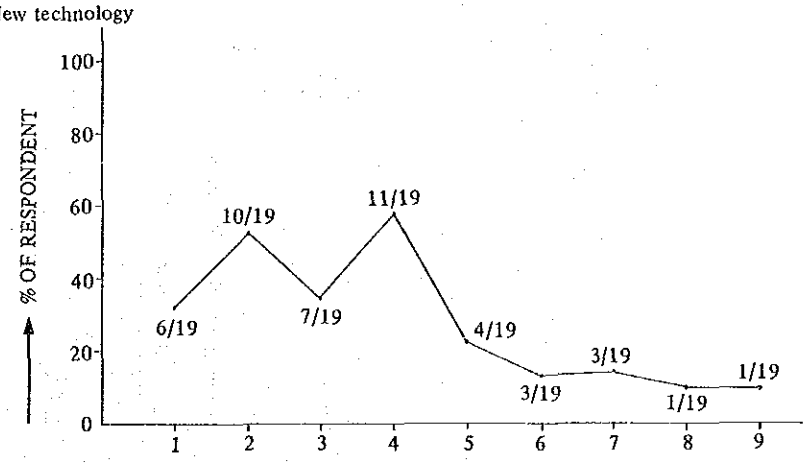


Fig. 4.4.6-37

(5) Management and Control (Fig. 4.4.6-38 (Q71-01))

In the aspect of the management control, the present situation survey and the required policies in future are as follows;

1) Profit Control System

Enterprises who totally understand the system are about 60% (17/30 companies), companies who adopt the profit & loss analysis are 40% (12/30), Breake Even Point (B.E.P.) analysis is applied 33% (10/30), companies who calculate B.E.P. for each product are 37% (11/30).

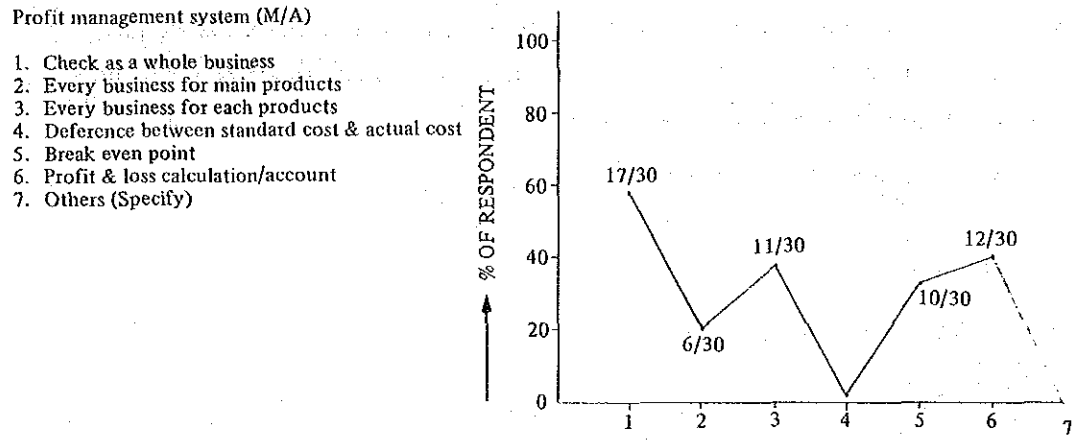


Fig. 4.4.6-38

2) Managerial Measures for the Future (Table 4.4.6-7 , Fig. 4.4.6-39 (Q73-01))

The following table shows the important matters in the automobile parts industry and points the direction the industry should have.

Table 4.4.6-7

Ranking	Item	%	No. of Enterpriese
1	Productivity	53.3	16/30
2	Technological R & D	50.0	15/30
2	Enlargement of Market Share	50.0	15/30
3	Quality Control	46.6	14/30
4	Product R & D	43.3	13/30
5	Upgrading Qualification	30.0	9/30
5	Production Control	30.0	9/30
5	Material Cost	30.0	9/30

High productivity and low cost are seriously important for the automobile parts whose majority are imported, and must be achieved to compete with the imported parts. Technological R & D is also important, and it is required to make every effort to produce a good quality by utilizing an international technology. It is also necessary to reduce costs by mass production in accordance with the enlargement of their market share. Quality control is absolutely necessary in the automobile parts production, and uniform quality is required. According to Product R & D plans, attentions for an increasing number of product items also never be failed. Keen attention should be paid for the production control and cost reduction of materials, because many of the materials are imported.

Above these indicate the future direction of the automobile parts industry. Of cause, these are many problems not to be able to solve on each enterprise base, so the government or the public organization aid is needed.

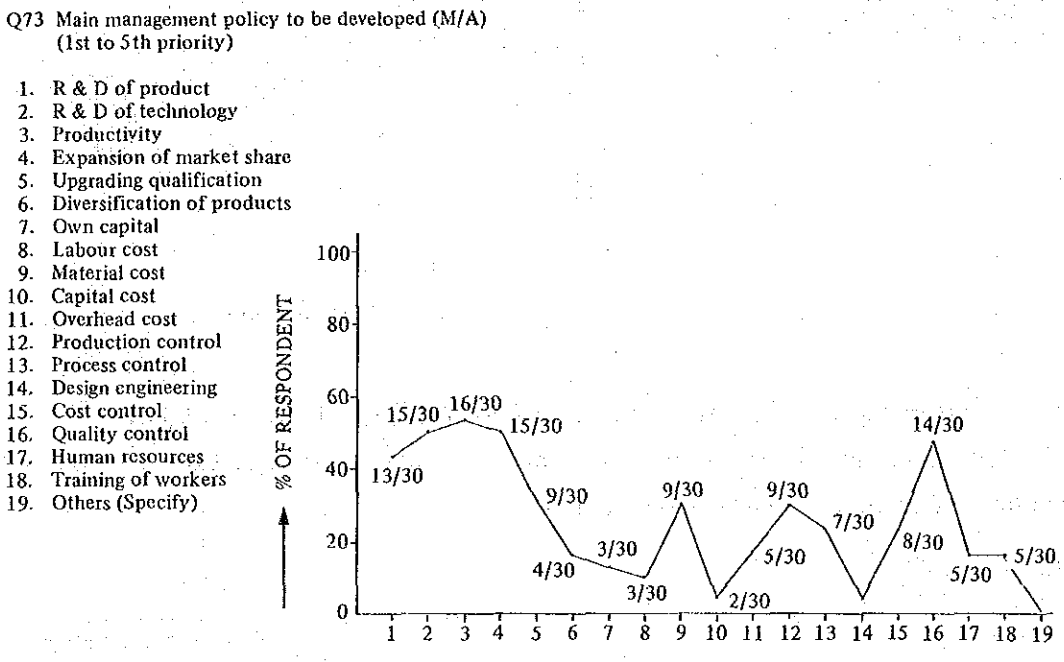


Fig. 4.4.6-39

3) The Government Support and Measures to be Expected

a) Measures for the Automobile Parts Industry Buildup in Thailand.

Every measures in Table 4.4.6-8 is effective, the government strong aids are greatly expected.

Table 4.4.6-8

Q74 Preferable government assistances and assessment of existing ones (M/A) (1st to 5th priority)

	1 Not useful	2 Useful	3 Very useful
Development of infrastructure			
1. Access road	1/5	3/5	1/5
2. Telecommunication	1/8	4/8	3/8
3. Electric supply	1/8	3/8	4/8
4. Water supply	1/10	4/10	5/10
5. Central sewerage treating		2/4	2/4
6. Pollution control		4/6	2/6
Technical/information services by public organization			
11. Training services		6/11	5/11
12. Consultancy services		5/10	5/10
13. Information services		6/13	7/13
14. Testing services		6/8	2/8
15. Laboratory		3/6	3/6
16. Standardization National		5/8	3/8
17. Quality control		2/6	4/6
18. Seminer/symposium		2/4	2/4
Financial/Merketing support Encouraging investment			
21. Tax rebate and tax exemption	1/16	5/16	10/16
22. Creidt assistance	1/14	4/14	9/14
23. Subsidy	1/10	3/10	6/10
24. Marketing		6/12	6/12
Protection of domestic products			
31. Import surcharge		4/11	7/11
32. Import restriction		3/9	6/9
33. Export promotion		3/14	11/14

b) Examples of the Automobile Parts Industry Buildup Plans in Japan.

The government buildup plans since 1956 greatly contributed for the Japanese Automobile Parts Industry's development. That is, several plans such as the Machine Development Lows (1956), Machinery and Electricity Lows (1971) and Machinery Informations Lows (1978) came into effect, and equipment modernization, increase of efficiency, improvement of production engineering and so on was promoted, and their production fields and specifications are arranged. Consequently, their design of parts, production engineering and etc. reached the level of the advanced country.

The scattering of quality and performance, and low durability were improved. Also, parts prices were improved to be lower than international prices, then productivity was elevated. Social problems such as security, environmental pollution and so on were well accomodated.

Practically, improved engineering for mold-manufacturing made it possible to precisely mass-produce the casting and forging parts, to manufacture precision metal working press products and to reduce costs; An employment of robot successfully improved the production engineering, and promoted a labor and energy saving; An improvement of the process control succeeded in an efficient production; The improved quality control made it possible to produce a uniform quality. Thus, the Japanese automobile parts industry has achieved a remarkable progress in this world.

In the other aspect such as a labor problem, the Skill Measurement Institution (qualifications for national examination) on each occupational classification for skilled laborers has been up-grading their technical levels. Otherwise, various kinds of spiritual motions have promoted a group activity and a team work activity.

Locally established Industrial Technology Centers and Vocational Training Schools have been contributed to local industry buildup.

As the nation wide project, the occupationally classified and assembled industry centers have been undertaking the industry buildup for their negotiation and promotion. For example, there are the Original Pattern and Material Center, the Automobile Parts Industries Association, the Automobiles Promotion Association and Others.

(6) Environment and Others (Fig. 4.4.6-4 (Q-90-00-01), Fig. 4.4.6-41 (Q90-01-01), Fig. 4.4.6-42 (Q94-01-01))

Many automobile parts industries are located in the industrial district (13/30 companies), however, six of 30 companies are situated in the residential district.

Have no claim about environmental pollution: 21/29 companies,

Have pollution claims: 8/29, detail of the claims are;

Noise: 4/8, Air (Smoke and Smell): 5/8, Water (sewage): 3/8.

Solutions for the noise problems in the metal working press industry and for the air pollution of various furnaces will both come up to serious problems. If the utilization of natural gas comes into effect, this should be positively promoted as the national important policy, because natural gas is more advantageous to the production cost and to the use of the national resources.

Water problems for the plating and other industries will be the future task to be improved.

Q90-0 What district is your firm situated in? (S)

1. Industrial district
2. Industrial district
   (customs free zone/free export zone)
3. Commercial area
4. Residential area
5. Not defined

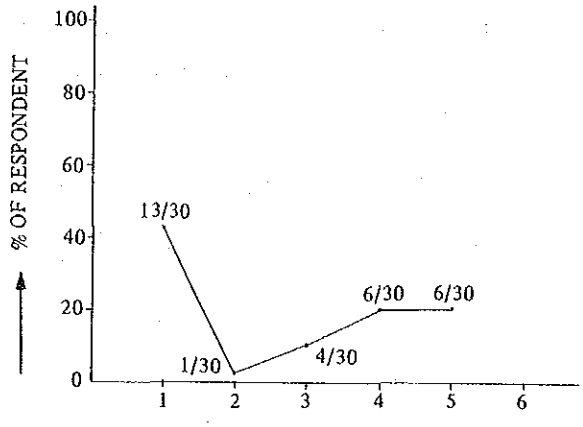


Fig. 4.4.6-40

Q90-1 Have you ever got claims of industrial pollution– (S) and What kinds of claims are they? (M)

1. Yes
2. No

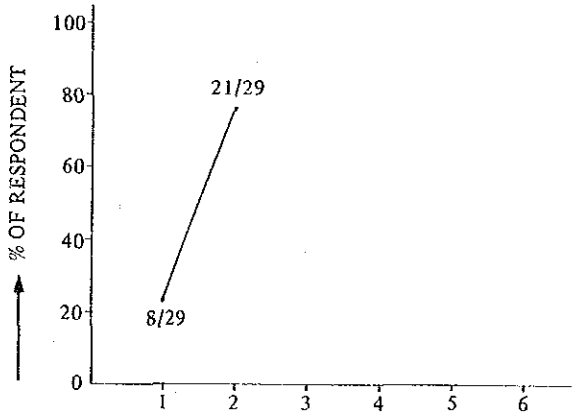


Fig. 4.4.6-41

Kind of industrial pllution (M)

1. Noise pollution
2. Vioration pollution
3. Air pollution (bad smell)
4. Air pollution (smoke)
5. Water pollution
6. Others (specify)

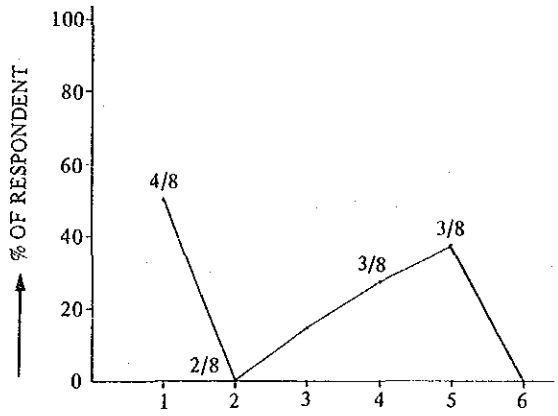


Fig. 4.4.6-42

Relocation program (Fig. 4.4.6-43)

As for the factory relocation program, companies of 20/26 have no program, six of 26 has it. The reasons for relocation are not environmental pollution, but narrow factory-land: 4/6, inconvenience for material procurement: 3/6.

Q94-1 Do you have relocation program of your factory? (S)

1. Yes
2. No

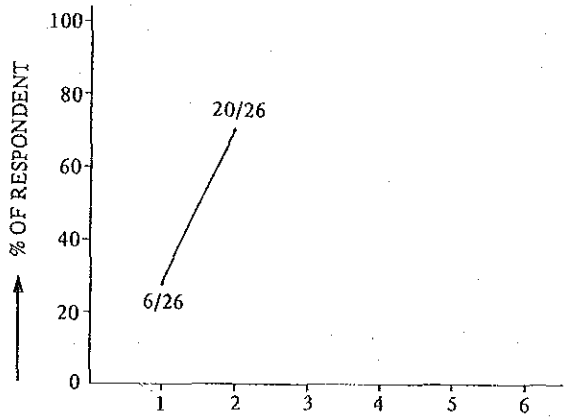


Fig. 4.4.6-43

(7) Current State of Things and Promotion of the Automotive Parts Industry

1) Current State of Things

The automotive industry is one of the most important industrial sectors of Thailand. In 1978 the gross sales of passenger cars totaled ฿ 4,280,000 x 10^3 (increase of 55% compared with the previous year) and that one of commercial vehicles totalled ฿8,800,000 x 10^3 which corresponds to an increase of 26.3% compared with the previous year.

a. Small-scale manufacturers

Small-scale manufacturers of automotive parts started their business from the imitation of finished products, and now they are marketing their products as repair parts or replacement parts. In reality very few of them have succeeded at reaching an international level with regard to cost and quality, because they are operating with small capital and obsolete plant and equipment.

b. Medium- and large-scale industries

Most of the medium- and large-scale industries of this sector are either joint-venture firms or are manufacturing their products under license from foreign parts manufacturers.

The quality and cost of the products of manufacturers of this class are in the international level.

c. Raw materials and cost

Most of the raw materials are imported. The prices are rather expensive compared with imported parts when the manufacturing lots are small, but substantial improvements regarding cost are expected concurrently with the increase of demand and standardization of the parts.

The results of the survey carried out this time are recapitulated in the followings.

1 Most of the automotive parts manufacturers of Thailand are small-scale firms operating with small capital (more than a half of the firms have turnover under ฿250 x 10^3/Y).
2 The turnover is small (70% of the firms have turnover under ฿4000 x 10^3/Y).
3 The scale of the plant & equipment is small (97% of the firms under ฿250 x 10^3).
4 As for the number of employees, 60% of the firms have less than 50 workers and 40% have 50 workers or more.
5 As for the types of products, most of the firms have side occupation and are manufacturing such products as industrial machinery, agricultural machinery, dies, etc., in addition to automotive parts.
6 As for the monthly production scale, there is no firm at all exceeding 1500 pcs/M, evidencing therefore that there are few mass-production manufacturers.
7 Measuring and inspection equipment are extremely rare.
8 The proportion of the cost accounting for research and development is small.
9 There is urgent necessity of improving the quality control system. The rate of defects after shipment is high.
10 The technical level of the firms is generally low (evaluation of the interviewer. Approximately 60% of the firms are classified as local level ones. (It is necessary to upgrade them as soon as possible to the national level or international level.)
11 Most of the raw materials are imported.
12 The domestic market accounts for the absolute majority (80%) of the turnover, but the exports are by no means negligible (20%).
13 As for the price competitiveness, there are 43% of firms with products above the market price.

14 Cost control and market survey are carried out in a general way, but a more careful following up is required.

15 As for the environment, most of the firms are located in industrial areas and complaints about pollution are relatively rare. Most of the firms do not have factory removal plan.

2) Promotion of the Automotive Parts Industry

a. Upgrading of the production technique

The level of the production technique can not be regarded as high. Generally speaking 60% of the firms are classified as local level ones, but it must be borne in mind that in reality there are firms whose technical level surpasses the said one, and the fostering of such buds in the form of modern subcontractor firms through intensive infusion of promotion means is one of the plausible alternatives to solve the impasse.

In particular, the high percentage of defective products is a serious problems, and concentrated efforts are required in order to solve it.

The following countermeasures are proposed in order to solve the aforementioned problems.

1 In the first place, the intervention of the government and public institutions in the form of guidance and aid is regarded as indispensable.

2 Re-education and training of manpower of various levels, particularly medium-level management personnel, is regarded as indispensable.

b. Increase and modernization of the manufacturing facilities and reduction of cost

Obsolete plant and equipment with low production capacity results into expensive costs. It is necessary to consider powerful cost-cutting measures concurrent with the expansion of the demand, and furthermore it is necessary to foster a group of firms with sufficient competitiveness regarding both price and quality by promoting the conversion of industrial structure through specialization and priority dedication to the principal occupation.

c. Diffusion of control techniques

1 Revision of the quality control

The quality control system as a whole is requiring an urgent revision. As things now stand the percentage of defective products is high, and it is difficult to manufacture products with stable quality. It is necessary to realize steady progresses regarding the matter through the diffusion of scientific quality control methods.

2 Process control

The implementation and fixation of inconspicuous but crucial control methods such as promotion of process standardization, design standardization, etc., are very important to prevent manufacturing process from being delayed. Technical guidance and diffusion regarding the said aspects are badly needed.

3 Raw materials and their control

It is very important to consider measures to save materials and to slash costs by upgrading the design engineering capacity in general, because the raw materials are imported. The improvement of the yield and the reduction of defective products is indispensable to save materials.

Guidance and aid of the government and public institutions is required also in connection with the definition and implementation of the basic conceptions regarding the learning of the aforementioned control techniques.

d. Improvement and equipment of the education and training system

It is necessary to acquire production techniques and control techniques regarding marketing, quality and cost, by improving the systems for re-education and training of executives, management personnel, workers and other kinds of persons related to the industry. Powerful guidance of an authoritative national institution is required in this connection.

e. Promotion of standardization

It is necessary to stabilize and improve the cost by promoting the standardization and normalization of both products and materials. Powerful guidance and aid of the government and public institutions are required in this connection.

Furthermore, standardization is required also in connection with the work.

f. Diffusion and official approval of measuring, test and inspection equipment

Public institutions should provide powerful guidance for the industries to equip themselves with simple measuring, test and inspection equipment.

The following measures should be considered in connection with more expensive equipment (e.g. material test equipment, composition analysis equipment, non-destructive inspection equipment, etc.).

1 To equip them in public institutions and to allow their use by private firms.

2 To equip them in each region for collective use by the private firms.

The accuracy of the equipment should be inspected periodically by the government or public institutions.

g. Supply of information

The government or public institutions should supply domestic and overseas information about technical matters, marketing, procurement of materials, etc., to the private firms. This is an important part to be played by the government and public institutions, and a powerful and aggressive attitude is required in this connection.

h. Encouragement of R&D activities

The government and public institutions should carry out powerful R&D regarding both products and processes, in order to provide guidance and aid to private firms. On the other hand, R&D activities of the private sector should be encouraged, by rewarding inventions and other encouragement measures. A plausible alternative in this connection is the acceptance of suggestions of the private sector by public institutions for commissioned research and test. Anyway, incessant R&D is indispensable because automotive parts are making rapid progress and furthermore model changes are very frequent.

i. Recapitulation

It goes without saying that efforts of private firms are indispensable for the automotive industry and the automotive parts industry, which are two of the most important industries of Thailand, to realize competitiveness in terms of cost and quality by upgrading them, but furthermore a substantial aid from the government and public institutions is required in this connection.

The aforestated considerations are shown in the following diagram.

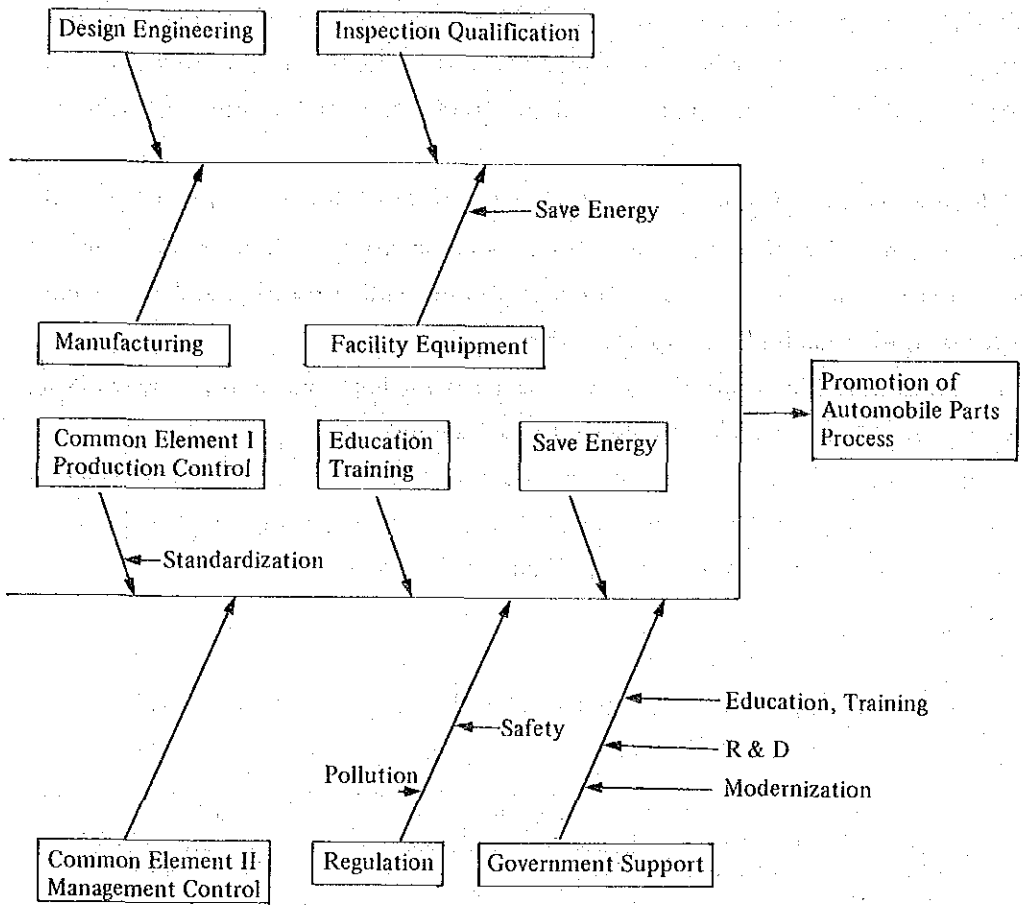


Fig. 4.4.6-44

Diagram of Promotion of Automobile Parts Process (Total System)

4.5 Present Situation and Problem by Processes

4.5.1 Casting

Casting industry in Thailand is not highly situated, in quality and quantity, but in ASEANS, it will be ranked in the higher class.

According to the investigation of APO, in 1979, its production of casting is in total 280,000 tons, and the employees are estimated 7000 to 7500. Of this production, the production of gray iron is estimated to be about 70,000 tons and occupies an main part in the casting.

Though there is not a rapid development after that year, but it is certain that it is steadily increasing. In particular, in recent year, firms in cooperation with Japanese firms are increasing, and the metal processing sector occupies its leading position and the promotion of this sector is becoming an important theme.

However, against this important theme, do the parties concerned in the metalworking industry of Thailand have a sufficient ability to correspond?

In its report of 1981 "Foundry and casting industry in APO member country", APO is analyzing and pointing up the actual state of Asean Countries, in aspect of technology, economy, education and training, and of Thailand, it has reported as is stated in the Table 4.5.1-1.

Table 4.5.1-1 Important Problems Faced by the Foundry Industry in APO Member Countries

Country	Technical	Economic	Training
Thailand	1. Lack of general knowledge of metallurgy and inefficient cupola operation 2. Lack of standard specifications for products and a high rejection rate 3. Lack of know-how on job simplification	1. Marketing: There is a lack of support from related industries to create mass production 2. High tax on to imported raw material used in foundry and high cost of inventory of imported raw materials 3. Inter-company competition without relating prices to real costs	1. Need for a basic training school for foundry workers 2. Too rapid migration of skilled labour 3. Need for training of foundry owners

(J.C. Wright, Hong Kong Productivity Centre)

At the opportunity the congress was held in Bangkok, 1981, supported by Jica-Technonet Asia, Thai reported on the casting industry in Thailand as is stated in the Table 4.5.1-2.

Table 4.5.1-2 Production of Castings

Items	Number of factory	Production	Uses
Gray iron casting	200	86,000 ton	Tin mining mach.
Steel casting	12		Suger mill
Malleable iron casting	5		Automobile parts
Die casting	30		Const. mach.

JICA-TECHNONET ASIA (1981)

In these important problems are included very complicated elements which can not be considered to be solved immediately, but, taking into account the development of the metalworking industry of Thailand, it is desired that a prudent plan is established promptly.

The present investigation was realized, under such circumstance, to grasp the actual situation of the metalworking industry at present (1984) and to establish a plan for its future development, and this chapter was dedicated to the sector of foundry industry.

A fact-finding survey on 334 companies and 235 subcontractors reveals that 56 companies (17.0%) and 24.0% of the subcontractors are engaged in casting process. However, only 41% of them are specialized in casting process as their principal line of business, the remainders are pursuing various additional lines of process.

The main objective of this project is to grasp the real status of these businesses to position them in the metalworking industry as well as to explore problems standing in the way of future development and find solutions for them.

For this purpose and as a guidance of promotion of casting process in the metal processing industry, Fig. 4.5.1-1, cause and effect diagram on promotion of casting process, showing main items marked with related questionaire code numbers (Q-No.), is prepared to clarify the problems and solutions.

(1) Scale of Business

1) History of company

As shown in Fig. 4.5.1-2, 66.1% of the companies in this field have a history of 10 years or longer.

The fact that the company has such a long history indicates smooth cooperation with neighboring communities, even though the company is on a rather small scale. This will give a great value as potential power to the promotion of casting industry.

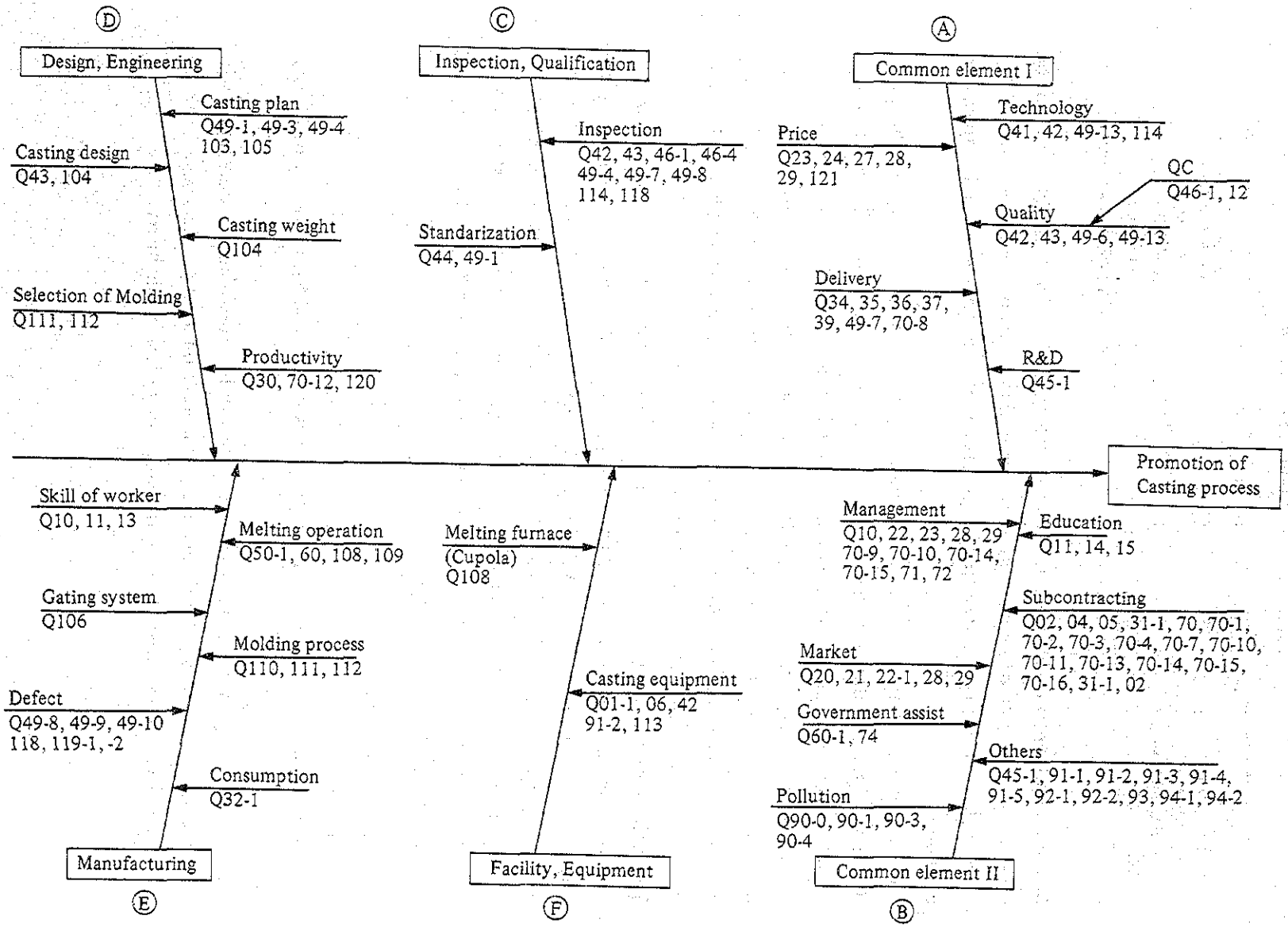


Fig. 4.5.1-1 Cause and effect diagram on promotion of casting process

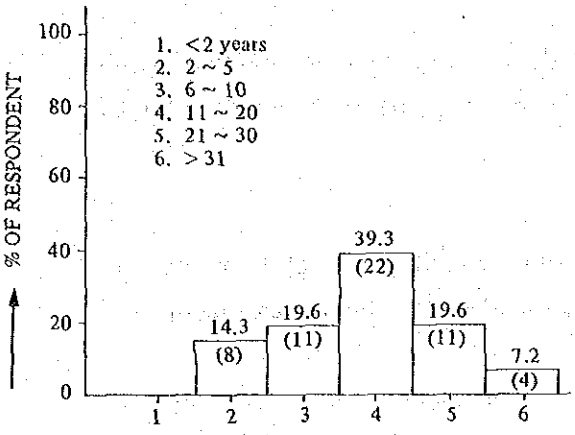


Fig. 4.5.1-2 History of company

Table 4.5.1-3 Capital and sales of casting industry

Scale of capital and sales x 10^3 ฿	Capital % (No. of firms)	Sales % (No. of firms)
<250	51.8 (29)	23.2 (13)
250 ~ 1,000	30.0 (17)	12.5 (7)
1,000 ~ 4,000	7.1 (4)	39.3 (22)
4,000 ~ 16,000	10.7 (6)	17.9 (10)
16,000 ~ 100,000	–	7.1 (4)
>100,000	–	–

2) Capital and Sales

As shown in Table 4.5.1-3, 80% of the companies have a capital of less than ฿1,000,000, assuming the typical form of minor enterprises.

As for the sales, it is interesting to note that the companies are divided into two groups; one is a lower level group whose sales are less than ฿250,000, and another is a relatively higher level group whose sales are from ฿1,000,000 to ฿4,000,000. From the above fact, we can presume that there is some difference in business activities between these two groups.

3) Plottage

As shown in Table 4.5.1-4, small-scale factories of 2,500 M^2 form the majority. On the other hand, it is also reported that there are three large-scale factories of more than 100,000 M^2.

Table 4.5.1-4 Scale of factory site

	Estate M^2	Ratio %	Firms
1	0 ~ 2,500	57.1	32
2	2,501 ~ 6,300	26.8	15
3	6,301 ~ 16,000	7.1	4
4	16,001 ~ 40,000	3.6	2
5	40,001 ~ 100,000	1.8	1
6	100,001 ~ 999,999	3.6	2

4) Scale of facilities

All companies (56) have facilities of only ฿250,000 or less, which are too small for casting process. The progress of mechanization seems very slow.

However, the fact-finding survey reveals that there are some factories equipped with ample facilities, and so there may be some defects in a part of the investigation by questionaire.

5) Employment scale

As shown in Table 4.5.1-5, 65% of the companies employ a staff of 49 or less. This is somewhat larger than that of the companies in the other lines of casting process, such as sheet metal and welding.

It is true that casting process requires complex procedures and needs more manpower, still the above figures seem to be too large and may not reflect the real status. The report also reveals that there is one large-scale factory which employs more than 300 persons.

Table 4.5.1-5 Employment scale

	Employment scale, person	Ratio %	Number of firms
1	1 ~ 9	–	–
2	10 ~ 29	12.5	7
3	30 ~ 49	51.8	29
4	50 ~ 99	16.1	9
5	100 ~ 199	12.5	7
6	200 ~ 299	5.4	3
7	300 ~ 499	1.7	1

Table 4.5.1-6 Ratio of specialization

	Specialization %	Ratio %	Number of firms
1	0 ~ 20	25.0	14
2	21 ~ 40	5.4	3
3	41 ~ 60	14.3	8
4	61 ~ 80	14.3	8
5	81 ~ 100	41.0	23

(2) Specialization

41% of the companies engaged in casting process are specialized more than 81% in casting process, and comparatively few companies are carrying additional lines of process.

The reason may be that casting process requires more special techniques than other processing fields. Nonetheless, it is difficult for these companies to ship their products in the form of finished goods, which forces them to be remained in the position of subcontractors.

(3) Kind of product

1) Kind of product

Table 4.5.1-7 shows kinds of product (top 10's) and the ratio of subcontract. The "Industrial machinery" field shows the highest percentage. This tendency is quite justifiable in view of broad varieties in kind and number of parts they require.

Another distinct field is the agricultural machinery. This may reflect the predominant position agriculture is holding in Thailand. This field also leads others in manufacturing products for its own use.

The next to the above is "Pipework or parts", which is followed by "Motor vehicles or parts", "Other machinery & equipment or parts", "Electrical and telecommunication machinery or parts", and "Pump & valves". These groups is ranked second to the first two fields.

"Motor vehicles or parts" fields is small, which indicates that the automobile industry in Thailand is still in the premature stage.

Also, "Pump and valve" field is unexpectedly small, taking into account relatively large demands for pumps and valves for public and construction works and other various types of machinery. It is presumed that rather many pumps and valves are being imported.

There are only two companies which place orders outside, one company subcontracts molding boards and another subcontracts various machine parts.

Table 4.5.1-7 Kind of product & status of subcontracting

	Category	Subcontracted in, % (No. of firms)	Own use % (No. of firms)
1	Industrial machine or part	50.0 (24)	23.1 (3)
2	Agricultural mach. or parts	47.9 (23)	30.8 (4)
3	Pipe work or parts	25.0 (12)	15.4 (2)
4	Motor vehicles or parts	18.8 (9)	–
4	Other mach. & equipment or parts	18.8 (9)	15.4 (2)
4	Electrical & telecommunication mach. or parts	18.8 (9)	–
7	Pump & valves	14.6 (7)	7.7 (1)
8	Civil structural & construction mach. or parts	12.5 (6)	7.7 (1)
9	Transport & habour equipment	10.4 (5)	–
10	Metal work mach. or parts	8.3 (4)	–
10	Kitchen equipment	8.3 (4)	7.7 (1)

2) Status of business

Family business, partnership with friends and single proprietorship amount to 75%, and only 26% have company system. No joint venture or foreign owned companies were found by this investigation, but it is known that there are several companies of such nature.

Table 4.5.1-9 shows various types of functional organization. About 84% are verbal instructions, and few companies prepare charts specifying functions and organizations. This is a disadvantageous factor for proper production control.

Table 4.5.1-8 Status of business

	Category	Ratio %	No. of firms
1	Family business/single proprietership	25.9	14
2	Partnership	48.1	26
3	Company	26.0	14
4	Cooperative	–	–
5	Joint venture with foreign firms	–	–
6	Government company	–	–
7	Foreign owned	–	–

Table 4.5.1-9 Organization chart

	Category	Ratio %	No. of firms
1	None	33.9	
2	Verbal function only	39.3	
3	Verbal job classification only	10.7	
4	Chart with line function	7.1	
5	Chart with classification	5.4	
6	Chart with line function and job classification	3.6	
7	Others (specify)	–	

(4) Actual condition of subcontractors

1) The history of the company as subcontractor

The frequency of doing production activity as a subcontractor is shown in Fig. 4.5.1-3. 65% are regularly doing subcontracted work, which is quite a high percentage, and 75% of them can manage to do all subcontracted work by themselves without subletting out any part of the work received.

Fig. 4.5.1-4 shows various kinds of companies which place orders outside. It is quite natural for those 73% of subcontractors to choose to receive orders from companies of same or larger scale. There are also many subcontractors which receive orders from government organizations and companies with foreign equity.

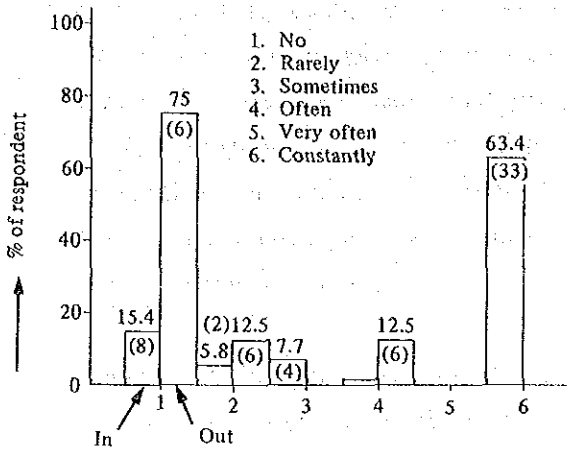


Fig. 4.5.1-3 Frequency of subcontracting

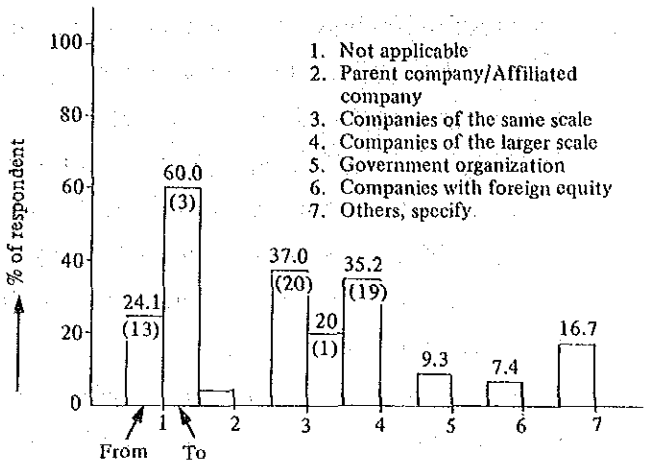


Fig. 4.5.1-4 Kinds of subcontracting work to/from

2) Purposes to work as subcontractor

The main purpose of subcontractors is to promote their production activity, which is clearly reflected in their answers Codes 1, 2 and 6 as shown in Fig. 4.5.1-5.

Also the survey reveals that the merit of stable supply of raw material gained 22%.

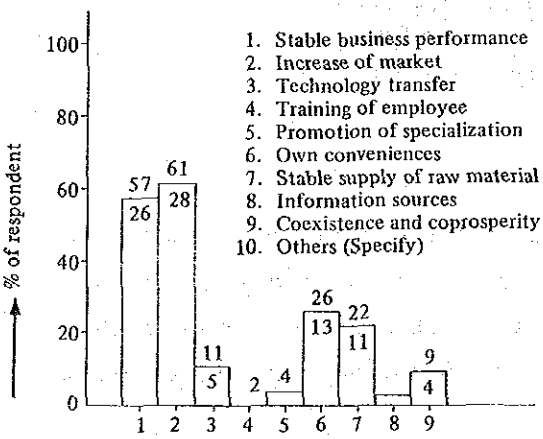


Fig. 4.5.1-5 Main purposes to get subcontracting job

Table 4.5.1-10 Kind of assistance, assistanted

		1. Get	2. Give
1.	Capital investment	16.2	–
2.	Provision of loans	–	–
3.	Machine & equipment procurement/supply	5.4	33.3 (1)
4.	Expert dispatch	–	–
5.	Engineering services	8.1	–
6.	Supply of indigenous raw material	2.7	–
7.	Supply of imported raw material	–	–
8.	Training of workers	–	–
9.	Costing	5.4	–
10.	Troubleshooting	–	–
11.	Follow up cell	10.8	–
12.	Utilities, consumables	2.7	–
13.	License	–	–
14.	Start-up advice	48.6 (18)	–
15.	Sequencial advice	10.8	–
16.	No advice	18.9	66.7 (2)
17.	Others (Specify)	–	–

3) Kinds of assistance and assessment of them

Table 4.5.1-10 shows various kinds of assistance given by their parent companies. You can see that 60% of the assistance are given in the form of advice, which is the highest percentage, and capital investment of 16% is unexpectedly small. There are no assistance in the form of expert dispatch, supply of imported raw material and training of workers. Also, "No advice" amounts to about 20%. These facts lead us to believe that relationship between the two are maintained mainly through dealing of subcontracted products, and many subcontractors are carrying their business on their own without any assistance from their parent companies.

Although investigation was made only on a few subcontractors, who sublet their orders to other companies, it seems that the relationship between these two parties is similar to the relationship between parent companies.

However, assessment of the assistance given by parent companies is high; i.e. 69% rated it good, 25% rated effective, and only 3% rated it poor.

Table 4.5.1-11 Assessment after assistance gotten/given

	1. Gotten %	2. Given %
1. Very poor	3. 1(1)	–
2. Relatively poor	–	–
3. Normally effective	25.0 (8)	–
4. Relatively good	3.1 (1)	–
5. Good	68.8 (22)	100 (1)
6. Excellent	–	–

Table 4.5.1-12 Guaranty of subcontracted product by you

	%
1. None	65. 1(28)
2. Replacement/correction only at delivery time	18.6 (8)
3. Less than three months	4.7 (2)
4. Three to six months	7.0 (5)
5. One year	4.6 (2)
6. More than one year	

4) Guarantee of subcontracted products

Table 4.5.1-12 shows the result of survey on kinds of guarantee on subcontracted products. You can see from this result that nearly 65% of the subcontractors do not give any kind of guarantee on their products. 20% of the subcontractors guarantee relacement/correction only at delivery time, and no more than 15% of the subcontractors give a guarantee for 3 months or longer.

This is a great disadvantage for the promotion of export of their products, and development of correct production policy is advisable.

5) After care of claims

Table 4.5.1-13 shows the result of survey on "after care of claims", which indicates that nearly half (44%) of the subcontractors do not have staff who handle claims. Claims

received by remaining companies are mostly handled by owners and managers.
A great improvement in handling claims is desired, as claim and guarantee are two sides of a thing and closely connected with each other.

Table 4.5.1-13 After care of claims by you

	%
1. None	44.0 (22)
2. Marketing staff	6.0 (3)
3. Marketing/Production staff	6.0 (3)
4. Manager	18.0 (9)
5. Owner	36.0 (18)
6. Others (Specify)	–

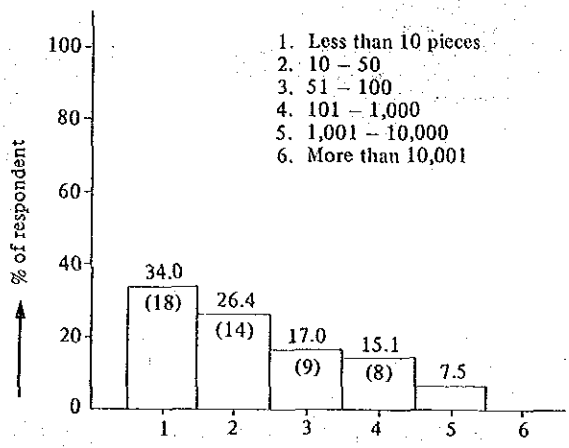


Fig. 4.5.1-6 Minimum order scale

6) Minimum order scale

As shown in Fig. 4.5.1-6, the percentage of minimum order of 10 pieces is 43%, less than 50 pieces reaches to 60%, whereas minimum order of less than 101 pieces accounts for less than 23%.

This low volume is due to weak industrial foundation. A gradual increase in quantity can be expected, however, it is also hoped that the subcontractors make their own efforts to cultivate the market.

7) Order route of subcontracting job

As shown in Table 4.5.2-14, the order route of subcontracting job is rather simple and the number of companies who received orders directly from their parent companies is considerably large.

This way, in a sense, is simple and has many merits, but on the other hand, such sales activity to approach to traders and dealers may also be necessary.

8) Distance up to the subcontractor

As shown in Fig. 4.5.1-7, 75% of the subcontractees are located within the distance of 40 km from the subcontractors and can get in touch with each other by means of automobile. On the other hand, 10% are receiving orders from subcontractors located more than 151 km away, which indicates that the scope of activity in getting orders is gradually expanding.

Table 4.5.1-14 Order route of subcontracting job (M/A)

	%
1. Through midleman	–
2. Through trader/dealer	–
3. From market	–
4. Through subcontractor's introducer	2.0
5. Directly through subcontractor	69.4 (34)
6. Others (Specify)	8.2 (4)

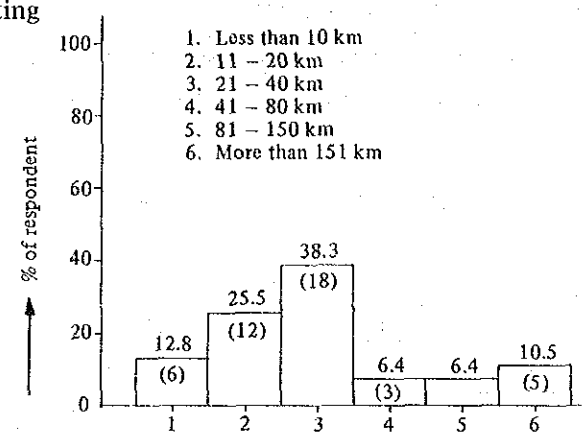


Fig. 4.5.1-7 Distance up to the subcontractor

9) Motivation to have started relationship with the subcontractor/subcontractee

Table 4.5.1-15 shows the result of the investigation on the motivation to have started subcontracted production.

Human relationship with owners or managers accounts for the majority of the motivation. The same situation exists in the other countries. On the other hand, the subcontractors which are making their own efforts to cultivate the market account for more than 45%. This should be highly appreciated as positive business activity.

10) Preferable subcontractors

As you can see from Table 4.5.1-16, large-scale companies are ranked high as the most preferable subcontractor and accounts for 43.5%. This is a natural form of subcontractors versus subcontractees. The unit order price must be low, but background advantages, such as stability of business, transfer of technology and supply of material may be the incentives to prefer large-scale companies. 30% of the subcontractors prefer companies of the same scale. This is probably because emphasis is given on cooperation rather than subcontracting work.

There are also some companies (22%) who wish to get work from government organizations. This is probably because they expect orders from these organization for casting products, such as manholes, casting iron pipes and valves to be used for public works, and also appreciate stability of business.

Table 4.5.1-15 Motivation to have started relationship with the subcontractor/subcontractee

	Subcontractor %	Contractee %
1. Neighbour	4.7	–
2. Relatives	–	–
3. Relationship between, owners/managers	55.8 (24)	75.0 (13)
4. Introduction by an influential man	4.7	–
5. By own market cultivation	44.2 (19)	25.0 (1)
6. Others (Specify)	2	25.0 (1)

Table 4.5.1-16 Most preferable subcontracting work from

	Subcontractor %
1. Not applicable	17.4 (8)
2. Parent company/affiliated company	6.5 (3)
3. Companies of the same scale	30.4 (14)
4. Companies of the larger scale	43.5 (20)
5. Government organization	21.7 (10)
6. Companies with foreign equity	2.2 (1)
7. Others, specify	6.5 (3)

11) Future prospects of subcontracting business (Future relationship with the subcontractor/subcontractee)

Table 4.5.1-17 shows the result of the investigation on prospects of the subcontractors for future relationship with their parent companies. Very few companies wish to terminate their relationship with parent companies or reduce subcontracting work. The majority (57%) of the subcontractors wish to maintain the present relationship, 32% even wish to strengthen their tie-up with parent companies. Almost all the companies have positive attitude toward subcontracting work. On the other hand, they have negative ideas to subcontracting others, which probably means they want to stay in the current situation and do not wish to expand further.

To further develop this positive attitude toward subcontracting, it may be necessary to establish healthy environment in terms of technology and dealings, etc.

In relation to this future prospect, the future policy for the subcontractors themselves shows the same tendency.

Table 4.5.1-18 indicates that they do not wish rapid increase of orders. 80% of the subcontractors wish to maintain the present level or gradual increase.

On the other hand, 16% of the subcontractors wish gradual decrease, which indicates complex relationship with the parent companies.

Table 4.5.1-17 Future relationship with the subcontractor/subcontractee

	Subcontractor %	Contractee %
1. Stop the new order	–	–
2. Decrease of order	4.5 (2)	25.0 (1)
3. Diversifying subcontractor	2.3 (1)	–
4. As it is	56.8 (25)	75.0 (3)
5. More close tie up	31.8 (14)	–
6. Others (Specify)	4.5 (2)	–

Table 4.5.1-18 Future policy for subcontract-in

	%
1. Rapid decrease	–
2. Gradual decrease	16.0 (8)
3. As same as present level	38.0 (19)
4. Gradual increase	42.0 (21)
5. Rapid expansion	2.2 (1)
6. Others (Specify)	2.2 (1)
	(50)

Photo 4.5.1-1 Fire plug

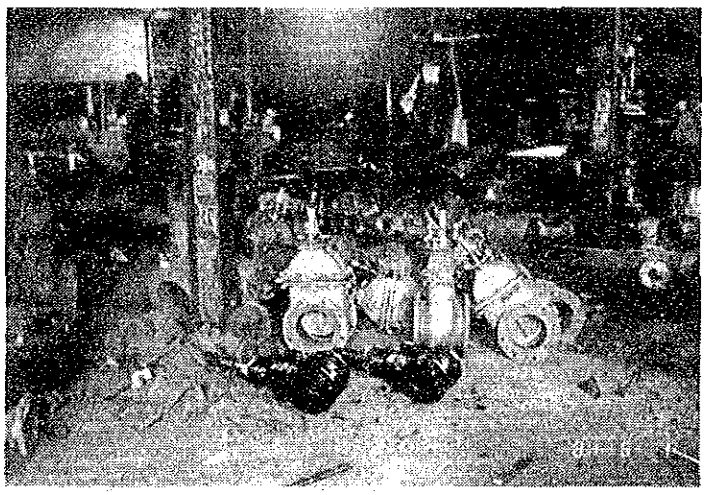


Photo 4.5.1-2 Gate valve

(5) Production technology and its level

1) Kind of casting products

Table 4.5.1-19 shows the main products in material and main products in weight.

Considerably large number of companies are engaged in production of gray iron, accounting for close to 85% of the firms in the casting industry. These firms devote 60% of their time to the production of gray iron.

Table 4.5.1-19 Kind of main products and possesion of products

	Category	Main products		Main products weight, % (No. of firms)			
		Rank 1, % (No. of firms)	Rank 2, % (No. of firms)	<30	31~50	51~70	>71
1	Gray iron	84.4 (27)	93.3 (28)	7.3 (1)	–	2.4	58.5 (24)
2	Ductile iron	3.1 (1)	3.3 (1)	50.0 (1)	–	–	50.0 (1)
3	Malleable iron	3.1 (1)	–	–	–	–	100 (1)
4	Carbon steel	–	–	–	–	–	100 (1)
5	Alloy steel	–	–	100 (1)	–	–	–
6	Copper alloy	3.1 (1)	3.3 (1)	57.1 (4)	28.6 (2)	–	14.3 (1)
7	Aluminum alloy	6.3 (2)	–	50.0 (4)	–	–	50.0 (4)
8	Die casting	–	–	–	–	–	100 (1)
9	Others	–	–	–	–	–	100 (1)

Only 3% of the firms are engaged in production of ductile iron, which is considerably small compared to 20% in Japan. Among various metal material for iron casting, ductile iron is most expected to develop and it is strongly desired that more firms enter into this field.

Production of steel casting and aluminum alloy casting is too small. Entry of firms into these fields are insufficient. Production levels of various materials should be in balance.

Table 4.5.1-20 shows the distribution of maximum weight of producible casting. The production levels of small, medium and large-size castings are almost equal.

Table 4.5.1-20 Maximum weight of casting and number of lot produced

	Weight, kg	Ratio, %	No. of firms
1	<10	22.9	11
2	11 ~ 100	12.5	6
3	101 ~ 500	16.7	8
4	501 ~ 1,000	18.8	9
5	>1,000	25.0	12
	Number of lot pieces		
6	<10	2.1	1
7	11 ~ 50	51.1	24
8	>51	46.8	22

As for the number of lots being produced, few firms are producing less than 20 pieces, and 98% are doing medium scale production of more than 11 pieces. This reflects availability of production and management technologies suitable for the medium scale production.

2) Pattern factory

75% (36 companies) are not making models. This production process is of different nature and usually is not followed by smaller companies.

3) Casting plan

The casting plan will define positions and sizes of sprues and risers, which are basic factors for casting. For doing this, it is required to understand drawings. Table 4.5.1-21 shows number of staff who can read drawings.

The companies which replied "none" account for 21%, which is an unfavourable factor for quality control. Even small companies should have at least one person who understand drawings.

Moreover, only 10 companies (20.8%) have engineers who can design a casting plan. This will be a major cause of inadequate quality control.

Table 4.5.1-21 Understanding of drawing (Q41)

	Category	Ratio, %	No. of firms
1	None	21.4	12
2	1 person	30.4	17
3	2 ~ 4 persons	30.4	17
4	5 ~ 10 persons	10.7	6
5	>10 persons	7.1	4

Table 4.5.1-22 Casting plan design (Q106)

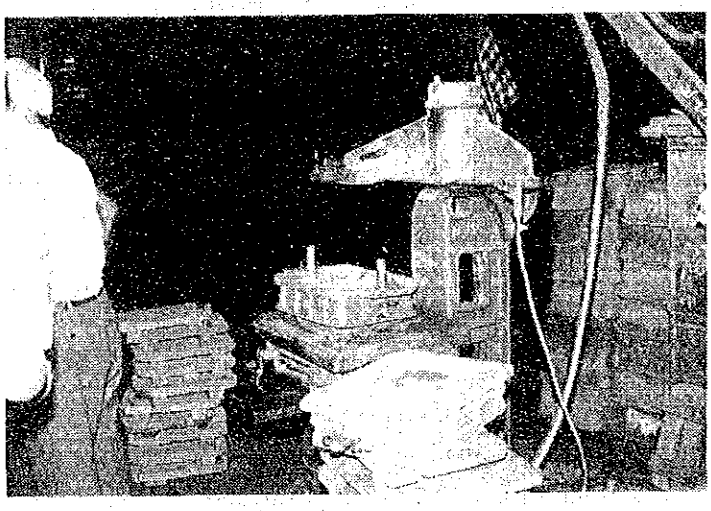
	Category	Ratio, %	No. of firms
1	None	2.1	1
2	Worker themselves	43.8	21
3	Engineers	20.8	10
4	Supply from customers	33.3	16

4) Melting technology

Table 4.5.1-23 shows the type of cupola used for melting of casting iron.

Old types have been decreased, whereas standard types account for about 70%. Heat blast type, which utilize waste heat and water cooled type suitable for use of many hours, are coming into wide use.

Photo 4.5.1-3 External view of cupola



:Photo 4.5.1-4 Small molding machine

As shown in Table 4.5.1-24, blending of material, which is a critical factor to determine quality of molten metal, is entirely entrusted to workers at 85% of the companies.

Table 4.5.1-23 Type of cupola (Q108)

	Categoly	Ratio, %	No. of firms
1	Simple design type	4.5	2
2	Conventional standard type	68.2	30
3	Hot blast type	6.8	3
4	Water cooled type	2.3	1
5	Others	13.6	6

Table 4.5.1-24 Person in sharage of melting material

	Categoly	Ratio, %	No. of firms
1	None	–	–
2	Workers themselves	85.4	41
3	Engineers	6.3	3
4	Others	8.3	4

The above situation will not serve the purpose of standardization of structure of cupolas.

5) Molding technology

Table 4.5.1-25, 26, 27, 28 show status of technologies such as method of molding, process, and sand control.

Floor molding has been used for large-size casting. However this molding method is not recommendable because of its low efficiency in molding process and low accuracy in measurements.

Table 4.5.1-25 Method of molding (Q111)

	Categoly	Ratio, %	No. of firms
1	Floor molding	14.9	7
2	Hand molding	42.6	20
3	Manually operated molding machine	36.2	17
4	Automatic molding mach.	6.3	3

Table 4.5.1-26 Molding process (Q112)

	Categoly	Ratio, %	No. of firms
1	Green sand process	85.4	41
2	CO_2 process	4.2	2
3	Shell mold process	4.2	2
4	Self-hardning process	–	–
5	Others	6.2	3

Table 4.5.1-27 Molding sand (Q110)

	Categoly	Ratio, %	No. of firms
1	Natural	53.2	25
2	Natural synthetic	40.4	19
3	Synthetic	6.4	3
4	Others	–	–

Table 4.5.1-28 Sand mixing (Q113)

	Categoly	Ratio, %	No. of firms
1	None	8.5	4
2	Manual mixing	48.9	24
3	Mechanical mixing	42.6	21

The use of molding machines for small and medium-size castings is becoming popular and accounts for 36%. This trend should be promoted further.

However, the majority of molding sand used is natural sand and mixing is sometimes not done at all or done manually at 57% of the companies. This means the quality and state of sand at the time of molding is not proper, and defects caused by sand, such as "blow", "sand inclusion", and "drop" often occur in the products.

Also percentage of CO_2 process and shell mold process is still unexpectedly low. A positive approach to application of these highly efficient methods should be taken.

6) Productivity

There are many ways to show productivity. This time investigation was made on the monthly productivity per person, as shown in Table 4.5.1-29.

In case of iron casting, productivity of 1.1–1.5 tons/p.m. accounts for 35% followed by 0.6–1 ton/p.m. and 1.6–2 tons/p.m.

This productivity is considered reasonable taking into account the exisiting production facilities and production system. The sharp increase in productivity requires implementation of various facilities, such as high-speed molding machines, giving a thought to the whole metal industry as a background.

Under the present circumstance, the highest productivity of the top class (1.6–2 ton/p.m.) is three times more than the lowest productivity of the 0.6–1 ton/p.m. class. This difference was probably resulted from a tangle of various complex conditions, however, this degree of result can be achieved by implementing rationalization of production system. Accumulation of such small progresses will stimulate further advancement.

Productivity of steel casting and cu casting is two steps lower than that of iron casting. This low productivity is considered to have been affected by the disadvantages resulted from a relatively small number of orders due to the limited market for these castings.

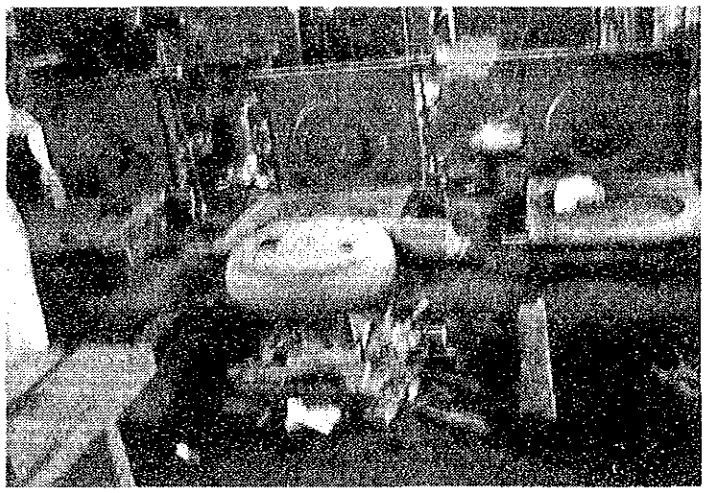


Photo 4.5.1-5 Pump casting mold

Table 4.5.1-29 Productivity/person/month (Q120)

	1 Iron casting (1)	2 Steel casting (2)	3 Malleable casting (3)	4 Al casting (4)	5 Cu casting (5)	6 Die casting (6)	7 Others (7)
1. Less than 0.25 tons	7.5 (3)	–	–	50.0 (5)	66.7 (4)		100 (1)
2. 0.26 – 0.5	5.0 (2)	66.7 (2)	–	30.0 (3)	16.6 (1)	–	–
3. 0.6 – 1	22.5 (10)	33.3 (1)	100 (1)	10.0 (1)	16.6 (1)	–	–
4. 1.1 – 1.5	35.0 (14)	–	–	–	–	–	–
5. 1.6 – 2 tons	25.0 (11)	–	–	10.0 (1)	–	–	–

This comparison shows two peaks; i.e. 11 150 and 300 – 600, 601 – 1500 pieces. It is presumed that Code 2 is a group of relatively large casting and codes 5 and 6 are a group of small-size casting. In any event, production system will greatly affect productivity.

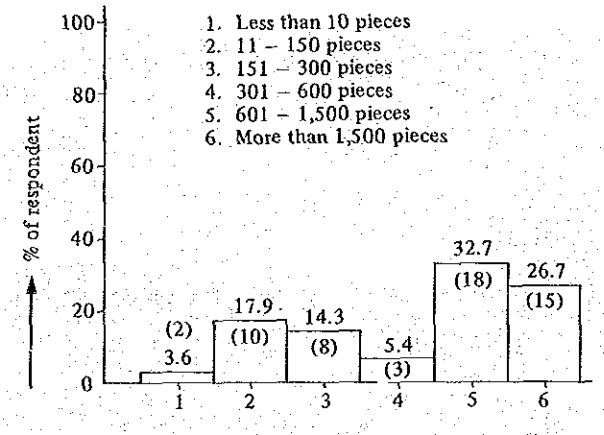


Fig. 4.5.1-8 Monthly quantative production

(6) Technical Control

1) Technical Control in Manufacturing

It is important for quality stabilization of castings to judge whether or not the process is suitable for each process.

Table 4.5.1-30 illustrates implementation frequencies of check items to be done for each process..

According to this Table, the factories which do not effect checkings are more than 70% in either process and, if 'Seldom" included, reach more than 90%. In this situation, it is almost impossible for them to stabilize quality of castings. There exists a great problem at issue in the casting processes.

Table 4.5.1-30 Checking frequencies in the casting process

	Sand mixing	Melting operation		Metal quality					9 Others
	1 Mois-ture	2 Tapping temp.	3 Quick test	4 Tensile strength	5 Hard-ness	6 Micro stracture	7 Chemical comp.	8 Non-desruc-tive test	
1. None	76.2 (32)	80.5 (33)	82.5 (33)	68.2 (30)	68.2 (30)	80.0 (32)	75.0 (30)	94.1 (32)	100 (18)
2. Seldom	14.3 (6)	9.8 (4)	10.0 (4)	22.7 (10)	20.5 (9)	12.5 (5)	12.5 (5)	–	–
3. Often	9.5 (4)	7.3 (3)	5.0 (2)	2.3 (1)	4.5 (2)	5.0 (2)	7.5 (3)	5.9 (2)	–
4. Very often	–	2.4 (1)	2.5 (1)	6.8 (3)	6.8 (3)	2.5 (1)	5.0 (2)	–	–

2) Defects and Countermeasures for them

As for kinds of defects shown in Table 4.5.1-31, those included in Blow hole and Pin hole are overwhelmingly large in number. It is assumed that these are due to unsatisfactory control over Sand mixing.

On the other hand, it is assumed that Sand inclusion may come from inadequacy of the gating system, while shrinkage may come from that of the feedhead system.

The fact that defects like Sand inclusion and Shrinkage in Al Alloy castings show low figures, is assumed that under the present conditions Al Alloy castings are not applied to any important parts and that inspection standards stand in a low position.

Table 4.5.1-31 Kinds of Defects

Troubles	1 Iron casting	2 Steel casting	3 Malleable casting	4 Al casting	5 Cu casting	6 Die casting	7 Others
1. Blow hole	92.7 (38)	100 (2)	–	88.9 (8)	100 (6)	–	100 (1)
2. Sand inclusion	51.2 (21)	100 (2)	100.0 (1)	11.1 (1)	33.3 (2)	–	–
3. Pin hole	97.6 (40)	100 (2)	100.0 (1)	55.6 (5)	66.6 (4)	–	100 (1)
4. Shrinkage	43.9 (18)	–	–	44.6 (4)	33.7 (2)	–	–
5. Others, specify ( )	4.9 (2)	–	100.0 (1)	–	–	–	–

Defect rates are shown in Table 4.5.1-32, and most of them concentrated on 11–20% and 6–10%. Although this rate totally varies depending upon inspection standards, if japanese standards are applied, then much higher rates will be indicated.

Table 4.5.1-32 Defect rates (Q118)

	1 Iron casting	2 Steel casting	3 Malleable casting	4 Al casting	5 Cu casting	6 Die casting	7 Others
1. More than 31%	2.4 (1)	–	–	–	16.7 (1)	–	–
2. 21–30	9.8 (4)	–	–	25.0 (2)	16.7 (1)	–	–
3. 11–20	19.5 (8)	33.3 (1)	–	12.5 (1)	–	–	–
4. 6–10	29.3 (12)	33.3 (1)	–	–	–	–	–
5. 4–5	19.5 (8)	–	100 (1)	12.5 (1)	–	–	–
6. Less than 3%	19.5 (8)	33.3 (1)	–	50.0 (4)	66.6 (4)	–	100 (1)

For companies with such a high defect rate, defects will become a stumbling block to their financial position and production control.

However, in reality, as shown in Table 4.5.1-33, answers to the survey show that there seldom occur troubles due to these defects.

The fact that both parent companies and subcontractors have accepted this aspect, may be because of looseness still pervading steadfastly in the industry at large.

Table 4.5.1-33 Occurence of troubles due to defects (Q119-2)

Frequency	1 Iron casting	2 Steel casting	3 Malleable casting	4 Al casting	5 Cu casting	6 Die casting	7 Others
6. None	–	–	–	10.0 (1)	20.0 (1)		–
7. Seldom	86.5 (32)	66.7 (4)	50.0 (2)	90.0 (9)	80.0 (4)		–
8. Often	10.8 (4)	16.7 (1)	50.0 (2)	–	–		–
9. Very often	2.7 (1)	16.7 (1)	–	–	–		100.0

This concept of defects on the part of both parent companies and subcontractors can be understood from the rate of defects discovered after delivery as illustrated in Fig. 4.5.1-9.

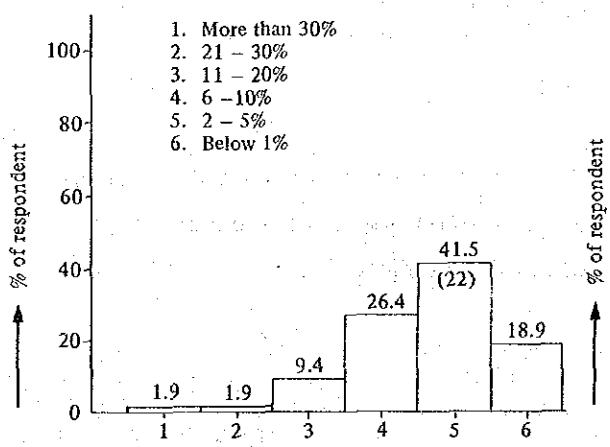


Fig. 4.5.1-9 Defect rate after shipping (Q49-9)

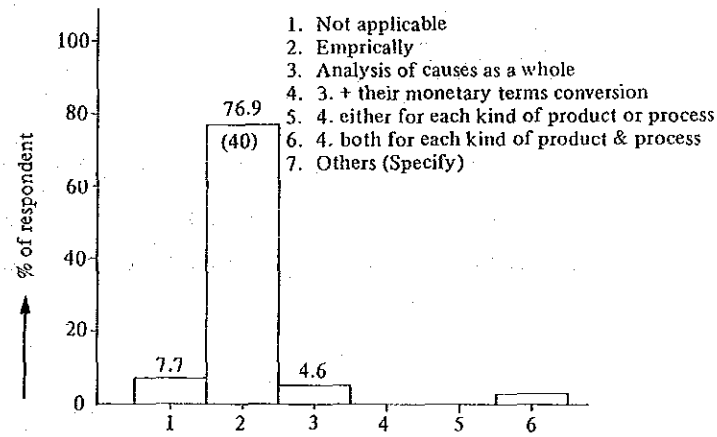


Fig. 4.5.1-10 Defects management system (Q49-10)

In short, the defect discovery rate of 6–10% shows as low as 26% and that of 2–5% shows as low as 41.5%, in which "looseness" of inspection standards can be imaginated.
As illustrated in Fig. 4.5.1-10, the majority of 77% of companies have taken counter-measures to defects from their empirical judgment.
This judgment is not necessarily wrong but cannot be regarded correct mostly. Scientific judgment is needed.
Photo 4.5.1-6 shows the defect "Blow hole" appeared after machined.

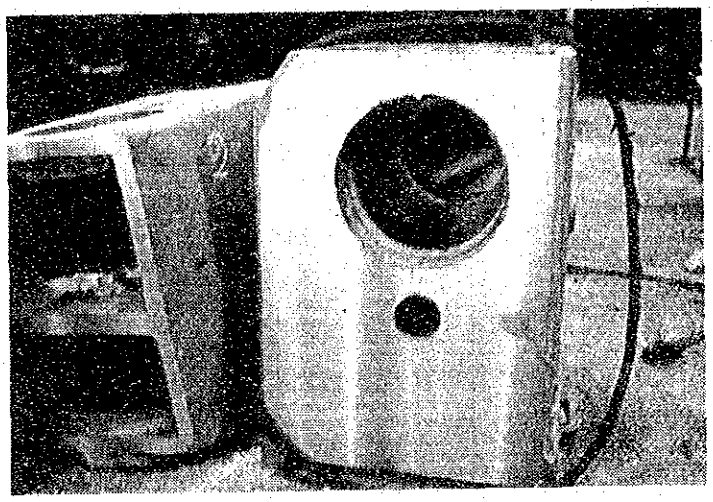


Photo 4.5.1-6 Defect "blow hole" appeared after machined

Photo 4.5.1-7 Scrap yard

3) Material Control

In this survey, the total stock level of raw materials as shown in Table 4.5.1-34, is as much as about 50% for an 8–30 day stock. In addition to this, that for over one month is as much as 48%. Although the stock level for one month is regarded reasonable, that for more than one months can be said excessive but must be considered inevitable taking into account of purchasing conditions in Thailand.

This survey centers only on volumes. However, it seems that quality level is not in a good condition which showed as, Photo 4.5.1-7. In the survey of interest in an important key in manufacturing (Q50-1), companies obtaining raw materials account for 90.7% (49 companies) which takes the lead, with 9.3% (5 companies) obtaining steel plate second. We would like to emphasize that an essential point of producing castings of high quality is to utilize good material and to conduct proper operation.

Table 4.5.1-34 Stock of raw materials (Q-60)

	Categoly	Ratio, %	No. of firms
1.	<7 days	1.8	1
2.	8 ~ 30	48.2	27
3.	1 ~ 2 months	19.6	11
4.	2 ~ 3	14.3	8
5.	>3 months	14.3	8

Table 4.5.1-35 Technical levels viewed survey team

	Level	Ratio, %	No. of firms
1.	Very low (Primitive level)	–	–
2.	Relatively low (Traditional level)	20.9	11
3.	Normal/Average (Local level)	59.3	32
4.	Relatively high (National level)	18.5	10
5.	High (International level)	1.8	1
6.	Extremely high (Exportable level)	–	–

4) Technical Levels

Taking into account of conditions in which companies are placed, it is quite difficult to judge technical levels. However, Table 4.5.1-35 shows technical levels which surveying staff of our project team have obtained at first hand from visits to companies, and also shows their appraisal taken an objective view of them.

According to this table, the majority of about 60% of companies consider their technical level as average, and 11% each of them as low or high. In promoting exports they are required to attain international levels. Since there exists only one qualified company for this purpose, for future promotion of the metal casting industry, the across-the-board levels should be raised.

5) Delivery Time

It is indispensable for subcontractors engaging in production activities to observe the delivery time.

Although process control is to be carried out aiming at this delivery time, in this survey we centered on delayed delivery time.

Firstly, Fig. 4.5.1-11 illustrates instruction methods of delivery time from subcontractors to subcontractees.

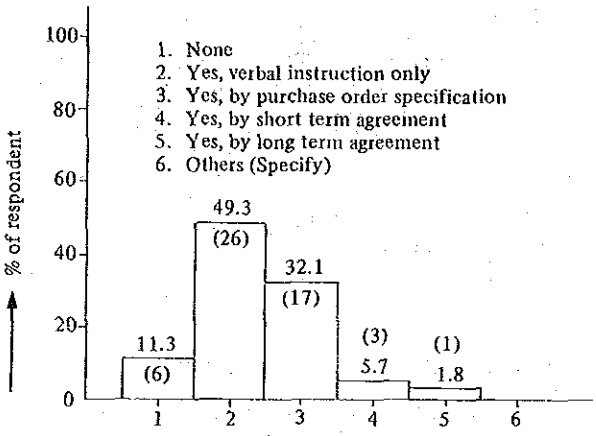


Fig. 4.5.1-11 Instruction of delivery time (Q34)

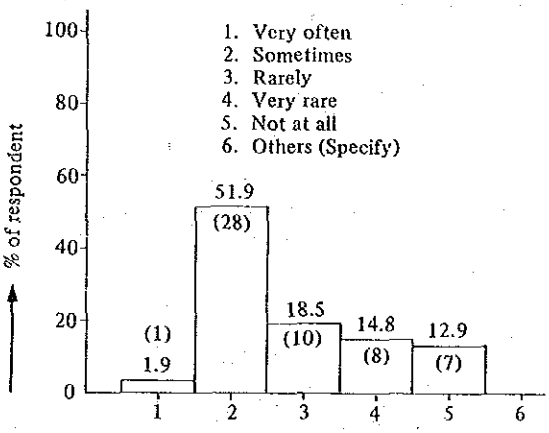


Fig. 4.5.1-12 Frequencies of delayed delivery (Q36)

Cases of no instruction account for 11%, that of verbal instruction only 49%, and that of purchase order specification more than 30%.

6) Delayed Delivery

Fig. 4.5.1-12 illustrates frequencies of delayed delivery, in which "very rare" or "not at all" holds 27%, while "sometimes" reaches 52%. There are many already established cases of delayed delivery.

As regards the number of days of delayed delivery is shown in Fig. 4.5.1-13, 17% is for "within 3 days" and 70% for "within 7 days". Furthermore, there are some cases of "1 to 2 months" delay, which cannot be judged from common sense.

As regards causes of delayed delivery, we surveyed by giving 5 possible causes, as illustrated in Fig. 4.5.1-14, in which every case shows the 20% level evenly, except for "delay of design engineering".

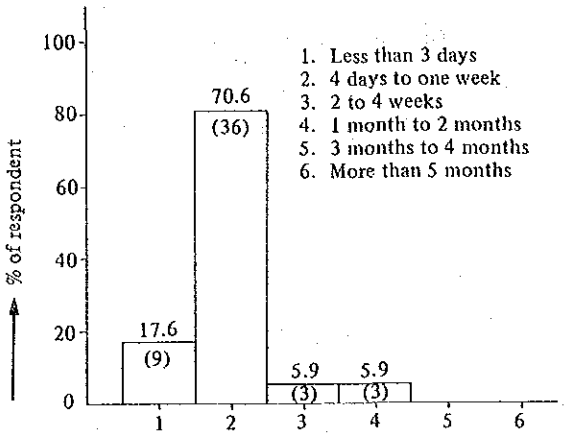


Fig. 4.5.1-13 Average term of delayed delivery (Q37)

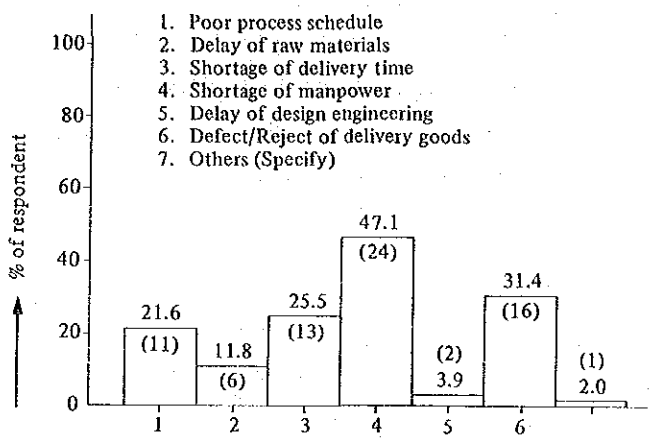


Fig. 4.5.1-14 Causes of delayed delivery (Q39)

Among the causes, "shortage of manpower" occupies nearly the majority, from which we can guess that they were forced to accept orders. Taking scheduling into consideration we can surmise that causes would come from looseness of process planning and also lack of control efforts.

The survey results of preventive measures for delayed delivery are illustrated in Fig. 4.5.1-15.

Fig. 4.5.1-15 indicates that companies taking no countermeasures whatsoever, take up 24% which corresponds to "looseness" of placing orders as stated above.

However, most of them have been adjusting processes at weekly, daily or regular intervals as the case may be, progress of which is unknown in this survey.

Companies' consciousness of delayed delivery will become a great impedient factor to the future of the promotional setup of metal casting industry, so that education/guidance to process control is particularly needed.

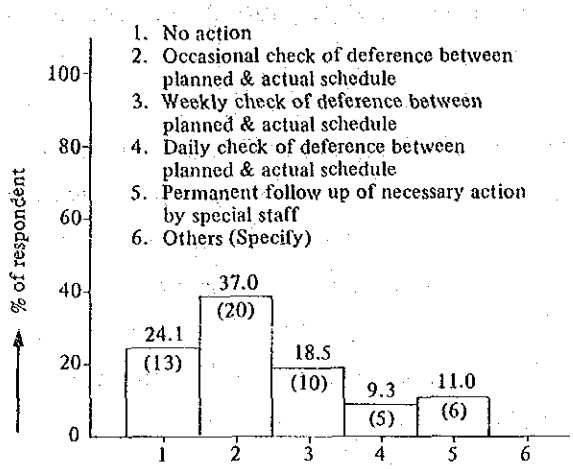


Fig. 4.5.1-15 Preventive measures for delayed delivery

(7) Inspection and Quality Control

1) Inspection

Casting inspection is usually made of appearance, dimension, cracks, internal defects, etc. The holding ratio of instruments necessary for making inspection, was surveyed as per Table 4.5.1-36.

Table 4.5.1-36 Holding ratio of inspection instruments (Q-42)

Length/Flatness	
1. Tape measure	83.3%
2. Carpenter ruler	72.2
3. Steel ruler	77.8
4. Caliper	69.8
5. Varier caliper	48.1
6. Micrometer	18.5
Testing	
81. Colour checker	1.9
82. Magna flux tester	–
83. Ultra sonic tester	–
84. Tensile strength tester	5.6
85. Chemical analyser	3.7
Harness	
51. Brinell tester	3.7
52. Vickers tester	1.9
53. Rockwell tester	5.6
54. Shore tester	3.7
55. Harnester	–
Temperature	
41. Etched stem thermometer	1.9
42. Thermo electric thermometer	1.9
43. Registance thermometer	1.9
44. Optical pyrometer	–
45. Surface thermometer	1.9
46. Temperature recorder	7.4
47. Immersion pyrometer	–

(Total 54 companies)

As for dimension measurements as basic testing, more than about 80% of total companies are equipped with various instruments.

However, Colour checker and Magnaflux testing aiming at crack discovery -- further advanced level of inspection, fall off sharply as less than 2%. On the other hand, a holding ratio of measuring instruments for strength/hardness is surprisingly as high as about 17%, except shore tester. We presume that large scale companies or subcontractors are provided with these instruments for the purpose of quality assurances.

The holding ratio of thermometers is unexpectedly low. They must realize that thermometers are indispensable for melting operation, heat treatment, etc.

Fig. 4.5.1-16 illustrates results of inspection records being kept. Companies not keeping inspection records are about 20% and those doing only visually are as high as about 70%, while companies keeping dimension check records are as low as about 55%. Putting all together, this shows that awareness of quality assurances is not enough.

On the other hand, material testing is conspicuous which might be instructed by contractors.

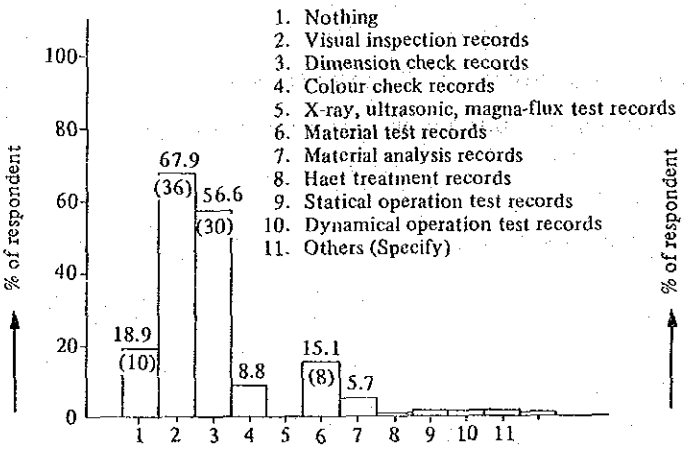


Fig. 4.5.1-16 Inspection records (Q49-8)

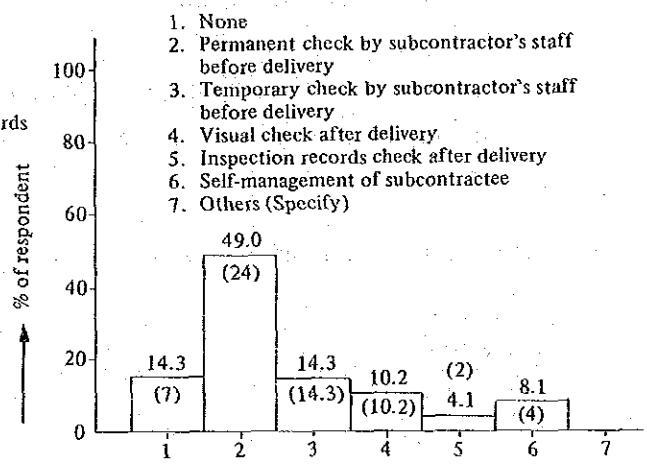


Fig. 4.5.1-17 Shipping Inspection System (For subcontracted good)

As regards inspection system illustrated in Fig. 4.5.1-17, companies performing visual check before delivery account for about 50% which shows almost the same tendency as the previous survey.

The foregoing inspections have been systematically arranged in Table 4.5.1-37.

① Companies conducting inspection when problems arise, account for about 30%, while those who perform total inspection and multiplysampling inspection account for about 30% each which are clearly divided into groups.

Table 4.5.1-37 Inspection system

The inspection system is (are):	
1. Systematic inspections are not available, "When trouble occurs check"	29.6%
2. First articles inspection	16.7
3. Single sampling inspection	11.1
4. Multiple sampling inspection	27.8
5. Sequantial sampling inspection	9.3
6. Total (100%) inspection	29.6
7. Without acceptance or purchasing inspection	–
8. With acceptance or purchasing inspection by standard inspection documents	3.7
Whom is it inspected by ?	
11. Workers themselves	74.1
12. Manager or the owner	44.4
13. Professional staff, patrol	1.9
14. Professional staff, stationary	7.4
Checking methods and items are:	
21. Visual check	81.5
22. Sensory check	13.0
23. Dimensional check	61.1
24. Clearance check for moving parts	5.6
25. Hardness check	11.1
26. Surface roughness check	3.7
27. colour check	–
28. X-ray check	–
29. Magna flux check	–
30. Noise check	–
31. Vibration check	–
32. Life test/running test	1.9
Feedbacked of the results of inspection is:	
41. Only in file, no feedback	14.8
42. Notice on the boad	18.5
43. Circulating notice or inspection record to workers/managers	14.8
44. Establishing counter measures by workers/managers	13.0
45. Establshing counter measures by professional staff, statistical quality control system	3.7

(Total 54 companies)

Table 4.5.1-38 Kind of standards (Q-44)

1	AKIS	3.7%	2
2	ASTM	1.9	1
3	BS	5.6	3
4	JIS (Owned)	3.7	2
5	JIS (Used)	16.7	9
6	ISO	3.7	2
7	TIS (Owned)	16.7	9
8	TIS (Used)	11.1	6
9	Customers std.	74.1	40
10	Own std.		7

② Inspections performed by workers themselves take up about 75% and those by supervisors 45%, which tells looseness in inspection control. Visual check is 80% and dimension check 60%, both of which command an overwhelming majority in methods of inspection.

③ Those who do not feedback these results of inspection are as low as 15%, while others seem to have discussions on supervisors, records and countermeasures.
This problem is an important step for stimulating the progress both on the technical and supervisory sides.

2) Qualification

Authorized standards are to be utilized for qualification. Table 4.5.1-38 shows various kinds of standards currently in use which include standards outside Thailand. Among them, JIS takes up as much as 17% which is probably because of Japanese interests invested in Thailand.

It is quite natural that TIS, the Thai standard, represents as much as 17%. There is a possibility that a considerable number of JIS and other standards outside Thailand, may be included in an overwhelming majority as Customers standards.

Except for specific products, various kinds of standards now prevailing are not desirable, and they should be unified as either TIS or ISO in the future.

Table 4.5.1-39 represents the survey performed on methods of instruction of quality specifications from subcontractors to subcontractees. Verbal instruction only represents as much as 50%. Subcontractors not giving instruction of quality specification to subcontractees amount to as much as 50%. From such a small amount as 14% it is not clear whether it is a general phenomenon. Generally speaking, loose instructions and accepting order at random prove that poor production engineering is accepted.

On the other hand, according to questionnaires of Q50-1, raw materials are taken as a major element which will give great influence to products quality. However, it is doubtful whether there are strict instructions given on purchase of raw materials.

Table 4.5.1-40 represents tolerance of main products, i.e. 80% centers on 1/10 mm which is appropriate for castings. Tolerance of 1/100 mm is not realistic except for precision casting.

Table 4.5.1-39 Instruction of Quality Specification from the subcontractor to subcontractee (Q49-6)

	From	To
1. None	13.5 (7)	50.0 (2)
2. Yes, verbal instruction only	50.0 (26)	–
3. Yes, by order specification	36.5 (19)	50.0 (2)
4. Yes, by special document/ drawing	11.5 (6)	–
5. Yes, 4. + dispatched instructor(s)/supervisor(s)	–	–
6. Others (Specify)	(52)	(4)

Table 4.5.1-40 Tolerance of main products (Q43)

	% (companies)
1. 100 mm or rough estimate	–
2. 10 mm	24.1 (13)
3. 1 mm	77.8 (42)
4. 1/10 mm	24.1 (13)
5. 1/100 mm	14.8 (8)
6. Less than 1/100 mm	(76)

(8) Design and Engineering

The field of design engineering is responsible for seeking for optimal conditions of casting. This field is to incorporate and accumulate scientific knowledge based on experience. We have investigated kinds of and supply system for engineering from this point of view, the outcome of which is summarized in Table 4.5.1-41.

Table 4.5.1-41 Kinds of and supply system for engineering

	Categoly	1	2	3	4	5	6	7	8	9	10	11	12	13
1	None	100	6.9	–	5.7	5.9	10.3	8.8	6.3	5.6	–	2.9	4.5	–
2	Copying	–	41.4	19.0	22.9	2.9	10.3	14.7	18.8	–	18.4	–	–	–
3	Buying from outside	–	3.4	4.8	5.7	2.9	10.3	2.9	3.1	–	23.7	–	–	100
4	Supply from customer	–	41.4	66.7	60.7	38.4	55.2	58.8	–	–	21.1	2.9	–	–
5	Supply from licencer	–	10.3	9.5	2.9	2.9	6.9	5.9	6.3	5.6	7.9	–	–	–
6	Occationally self-engineering	–	13.8	11.9	11.4	–	–	8.8	9.4	–	5.3	–	–	–
7	Partially self engineering	–	13.8	16.7	17.1	2.9	17.2	32.4	15.6	–	28.9	37.1	9.1	–
8	Pull engineering in the firm	–	6.9	4.8	2.9	44.1	17.2	2.9	65.6	83.3	42.1	57.1	86.4	–
9	Others	–	–	2.4	–	–	–	–	–	–	–	–	–	–

Note: 1: None
2: Conceptional design
3: Specification
4: Basic design
5: Functional design
6: Structural design
7: Detail design
8: Production engineering
9: Procurement engineering
10: Selection of material
11: Material flow plan
12: Team engineering
13: Others

According to this survey, about −50% of companies are provided with raw materials by customers except for some exceptional cases. In this sense, relationship between subcontractors and their parent companies will have to be closer.

It was revealed that as for production methods, material supply, etc. they have carried out in-house engineering as their own business.

To sum up, it has become known that they are taking a rational form; engineering relating to functions of products is to be carried out by contractors, while a realistic engineering for manufacturing is to be carried out by subcontractors.

They are to decide concretely on these areas of responsibilities, taking into consideration of the abovementioned gating system (Q-106), dimension tolerance (Q-111, 112), production quantities (Q-70-12), production capacity (equipment and expertness), etc.

(9) Education and Training

1) Educational levels of employees

Although we do not think that educational levels of employees relate direct to production activities, Table 4.5.1-42 shows educational levels of employees classified by scale of company.

Table 4.5.1-42 Educational level of the majority & No. of employees (Q11)

		01	02	03	04	05	06
	Educated years	<9 persons	10 ~ 29 persons	30 ~ 49 persons	50 ~ 99 persons	100 ~ 199 persons	200 ~ 299 persons
1	0 ~	12.5 (9)	28.6 (16)	55.4 (31)	71.4 (40)	85.7 (48)	85.7 (48)
2	1 ~ 3	8.9	19.6 (11)	26.8 (15)	17.9 (10)	8.9 (5)	8.9 (5)
3	4 ~ 6	3.6	14.3 (8)	5.4 (3)	7.1 (4)	3.6 (2)	5.4 (3)
4	7 ~ 10	19.6 (11)	5.4 (3)	3.6	1.8	1.8	–
5	11 ~ 20	21.4	17.9 (10)	5.4	1.8	–	–
6	>21	34 (19)	14.2 (8)	3.4	–	–	–

As shown in this Table, the majority of employees are on the low educational level. Especially this tendency appears in a large scale of company.

On the other hand, Fig. 4.5.1-18 shows ratios of employees, so-called primary class experts, with experience of 5 years or more.

Almost evenly distributed, these ratios show that conditions depend upon individual companies.

Training systems for these workers are illustrated in Fig. 4.5.1-19.

Fig. 4.5.1-20 is the appraisal of employees morals which are regrettably not on a high level.

Since employees' morals and also engineering are a big problem which cannot be solved by in-house training, establishment and consolidation of Governmental organizations for training is particularly desired.

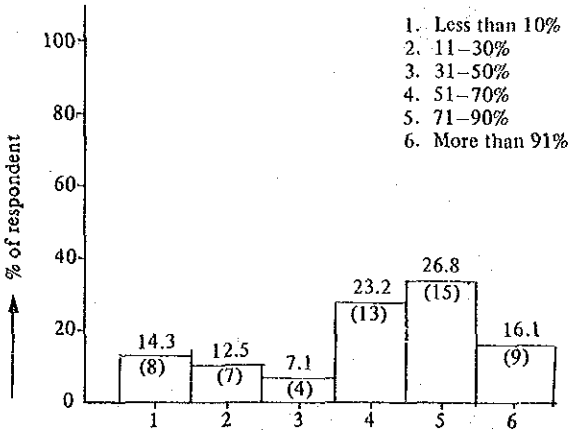


Fig. 4.5.1-18 Empirical level of workers (% of 5 years or more)

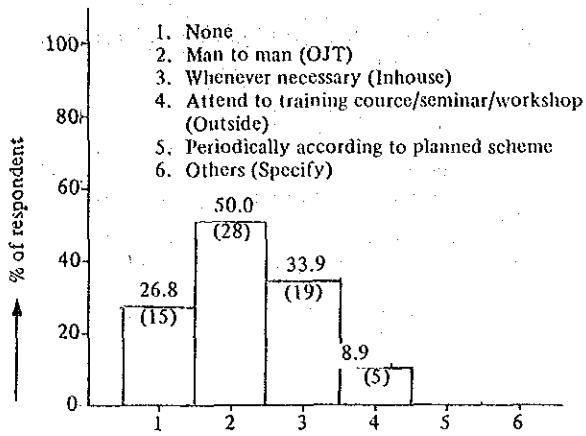


Fig. 4.5.1-19 Training system (Q14)

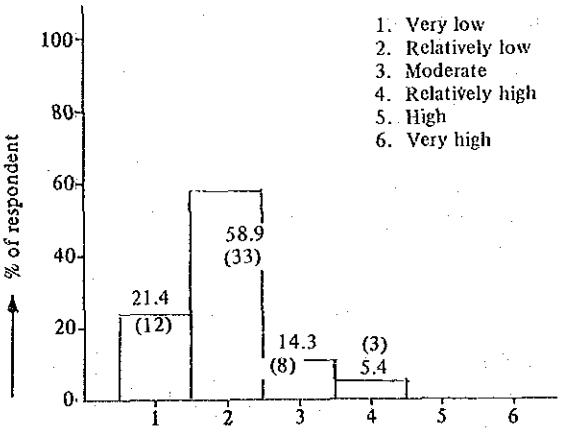


Fig. 4.5.1-20 Moral of employe

(10) Sales

1) Price Levels

Prices of castings are usually governed by contractors and the market. Table 4.5.1-43 represents general examples.

Prices are also decided upon in proportion to market prices by adjusting contractors' indicated prices and also subcontractors' own position, the relation of which is shown in Table 4.5.1-44.

Table 4.5.1-43 Price level of casting

	% (companies)
1. 31% and above higher	1.8 (1)
2. 21%–30% higher	–
3. 11%–20% higher	–
4. 1%–10% higher	8.9 (5)
5. Market price	82. 1 (46)
6. Less than market price	7.2 (4)

Table 4.5.1-44 Decision making system of price (Q27)

	% (companies)
1. Same as quotation/estimation of subcontractee	21.4 (12)
2. After comparing with self-estimation (target price)	32. 1(18)
3. After comparing market price	39.3 (22)
4. Short term agreement of price (Less than 6 months)	3.6 (2)
5. Long term agreement of price (More than 6 months)	3.6 (2)
6. Others (Specify)	–

We have shown the outcome of our survey regarding products prices in Table 4.5.1-45. These prices show the average value for each kind of material, which varies in individual cases, but is the reasonable value viewed from the macrocosmic standpoint.

Table 4.5.1-45 Average price of castings (Q121)

Category	1 Iron casting	2 Steel casting	3 Malleable casting	4 Al casting	5 Cu casting	6 Die casting	7 (Others)
1. Not applicable	–	–	–	–	–	–	–
2. Less than 10	89.7 (34)	25.0 (1)	–	–	–	–	–
3. 11–15	10.3 (4)	25.0 (1)	–	33.3 (3)	–	–	–
4. 16–20	2.6 (1)	25.0 (1)	–	11.1 (1)	40.0 (2)	–	–
5. 21–25	–	–	100 (1)	55.6 (5)	20.0 (1)	–	50.0 (1)
6. 26–30	–	25.0 (1)	–	11.1 (1)	–	–	50.0 (1)
7. More than 31	–	–	–	–	40.0 (2)	–	50.0 (1)

Although these prices are regarded lower by 20% than those in Japan, we cannot simply come to the conclusion since manufacturing conditions are fairly different between them.

2) Production Orders

As shown in Table 4.5.1-46, most of production orders are for 8–15 days, followed by 16–30 days, which seems to be reasonable. Since some companies have orders in hand for 1–5 months, if joined subcontracting, subcontractors will be able to obtain appropriate volume of production orders.

Table 4.5.1-46 Production orders (Q22-1)

	Ratio %	No. of firms
1. Non	3.6	(2)
2. One week or less	7.3	(4)
3. 8–15 days	36.4	(20)
4. 16–30 days	23.6	(13)
5. 1–5 months	21.8	(12)
6. More than 5 months	7.3	(4)

Table 4.5.1-47 Payment terms of subcontracted goods (Q26)

	Ratio %	No. of firms
1. Cash on delivery	5.5	(3)
2. Cash + Credit	40.0	(22)
3. Credit (Less than one month)	3.6	(2)
4. Credit (2 to 3 months)	43.6	(24)
5. Credit (4 to 6 months)	7.3	(4)
6. Others (Specify)	–	–

3) Payment Terms

Payment terms are shown in Table 4.5.1-47 which may be accepted as commonsense on the whole.

(11) Environmental Pollution

The casting industry is a field in which environmental pollution occurs much. Without employing any countermeasures for this environmental pollution, advancement of the casting industry cannot be expected.

Table 4.5.1-48 shows the outcome of survey made as to whether they have claims arising from an outbreak of industrial pollution. This table proves that about 38% of companies have incurred claims.

There are noise vibration, air pollution (smell, smoke), water pollution, etc. as kinds of pollution, all of which occur involved in casting process. Since cases of industrial pollution regarding air are quite a lot, time has now come to employ preventive measures for industrial pollution under the Government's guidance.

General survey results relating to this industrial pollution will be examined further in .....

Table 4.5.1-48 Kinds of pollution and claims (Q90-1)

(a)

	Ratio, %	No. of Co.
1. Yes	37.7	(20)
2. No	62.3	(33)

(b) Kind of industrial pollution (M)

	Ratio, %	No. of Co.
1. Noise pollution	21.1	(4)
2. Vibration pollution	15.8	(3)
3. Air pollution (bad smell)	68.4	(13)
4. Air pollution (smoke)	89.5	(17)
5. Water pollution	15.8	(3)
6. Others (specify)	–	–

(12) Proposal for Development of Casting Industry

Metal fabrication industry plays an important role in the development of industrial development of Thailand. In particular, casting is basic for the machinery industry and taking into consideration that the quality of castings is directly connected with the capacity of machinery, the rapid progress casting technique is specially desired.

The progress of the casting technique can not be attained only by paying attention to the technique of production but the instructions and assistance by the governmental organization for the administrative technique, standardization and disciplinary study and training, etc., that form its periphery.

The project of investigation of this time was effectuated as a part of the said fomentation, and summing up the crads of questionnaire and the field investigation, a proposal for the elevation of casting technique and the development of the casting industry is elaborated as follows:

1) Elevation of technique of production

① The level of technique of production in general can not be said the first class.

The most notable point is that the quality specification of products is not established clearly. This can be said of both giver and receiver of the orders, and is reflecting the poor recognition of the importance of quality.

However, in some industries, specially, in industries that are dedicated to subcontract of fabrication of parts of automobile, agricultural machinery, etc., the recognition of the importance of quality specification is at a sufficient level.

Table 4.5.1-49 Model of Curriculum of Disciplinary Study for Engineers

Priority	Class	Item of Training	Method of Execution
1	Engineer	Plan of casting process Plan of gatting system Technique of melting operation Metallic materials Technique of melting Molding operation Technique of casting mold Molding machine Technique of inspection External & internal inspection Quality inspection	Study in Institute (long term) (Basic course) Study in Seminar (Advanced course)
2	Supervisor	Plan of casting Technique of melting Technique of molding Technique of finish and inspection	Study, training in Institute (long term) (Basic course)
3	Worker	Melting operation Molding operation Finishing operation Inspecting operation	Study in Institute (Basic course) Instruction by circulation and training in the firm

Note: Supervisors and workers will be trained using a higher training institute, and the ability will be authorized by the testing of capability.

To try to amplify this atmosphere will become motive that leads to the elevation of quality of casting products.

② If it is seen from the viewpoint of the guarantee of quality, with an idea higher than the quality specification, the level of recognition must be said to be lower.
There exist very few yet the firms that are effectuating positively the detection of cause of occurrence of defects and the quest of measures for its prevention.

③ The equipment of fabrication is still poor, and is aged, with low productive capacity and low efficiency. And it seems to be impeding the elevation of quality.
In particular, the molding machine, sand treating equipment, blast furnace and installation of transporting machine can be said insufficient.

④ For the administrator it is not necessary to study the fundamental knowledge of technique profoundly, but it is necessary to obtain the understanding of the basis of the practical technique of production, and it is desired to establish the means to encourage the study this respect.

2) Diffusion of Technique of Administration

① The quality control is not sufficiently diffused. For example, Fig. 4.5.1-21 shows the items of quality control and the result of checking of their execution by a sheet of investigation. According to this checking, it is known that most of the firms are not exercising it or are leaving it to the workers, almost no firm is exercising a scientific quality control.
Under such a condition, it is very difficult to maintain the production of castings of stabilized quality.

② The level of control of schedule of work is also considerably low. Accordingly, delays in delivery occur frequently and the concern for the measures to prevent them was considered not so high.
In regard to the above-mentioned importance of the technique of administration, it is necessary to continue a long time study of theory and practice on its basic idea and on the method of execution.

3) Necessity of establishment of the system of education and training.

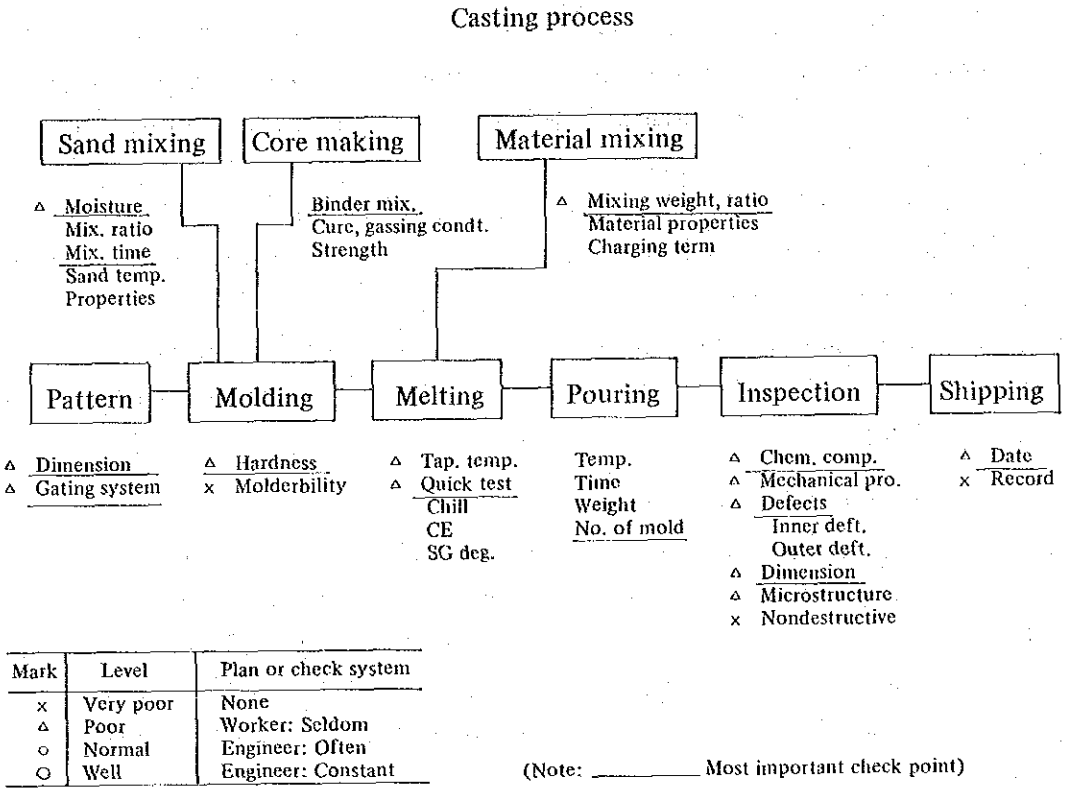


Fig. 4.5.1-21 Control items on casting process
(Items of quality control and actual condition of its execution)

As for the engineers, it is necessary to educate them, placing the focus on the technique of production and on the technique of administration, from the basic principle to the actual operation, and it is desirable that an organization of state with authority undertakes this task.

An example of its carriculum is shown summerized in the Table 4.5.1-49.

Supervisors and workers should be educated with focus on the practice so as to learn the precise and safe operation.

As for the organization for this task, a specialized national organization is appropriate for it. It will be useful to establish a system of testing the technical capability to authorize the ability.

4) Acceleration of Standardization

It is necessary to try to elevate the stability of quality and the economical efficiency by the acceleration of standardization of the products and materials. And the adoption of these standards will be recommended to the diverse firms to diffuse them.

As to the operation, the application of the standard will be considered also, and the plan will be established to encourage the elaboration and adoption of the standard of operations.

5) Diffusion and examination of equipment of test and inspection

The diffusion of the simple equipments for test and inspection that are required in the site of production for the stability and elevation of quality will be attempted.

For example, relative to molding, hardness meter of green sand mold, moisture meter, relative to melting, before furnace testing apparatus, thermometer, etc., will correspond. However these apparatus will lose easily their precision during their use, accordingly, periodical inspection and examination by a national organization are required, for which it is necessary to establish the measuring equipment.

6) Acceleration of modernization of installation

In order to accelerate the modernization of the installation and equipment necessary for foundry, finance and measures of protection within the tax system for the apparatus with specified efficiency and capacity are to be considered.

For example, automatic molding machine, blast furnace of high efficiency (cupola or electrical furnace), shot blast, apparatus for inspection will correspond. And as for the efficiency and capacity, it will be decided taking into consideration the actual state and the prospect of future.

7) Encouragement of R & D Movement

In order to activate the will of production in the foundry industry, the R & D movement is to be encouraged. And also, it is desired that the national testing organization will pick up the idea of private sector, and undertakes the trusted test, examination and guidance.

For example, the technique of use of natural gas produced in Thailand. Exploitation of cupola of combined use for natural gas, heating furnace for heat treatment, etc., are the study and exploitation that will contribute much for the reduction of import of oil.

8) Summary

Aiming at the processing of metal, especially the foundry sector, the items of investigation which have been exposed by now, are summed up below as Fig. 4.5.1-22.

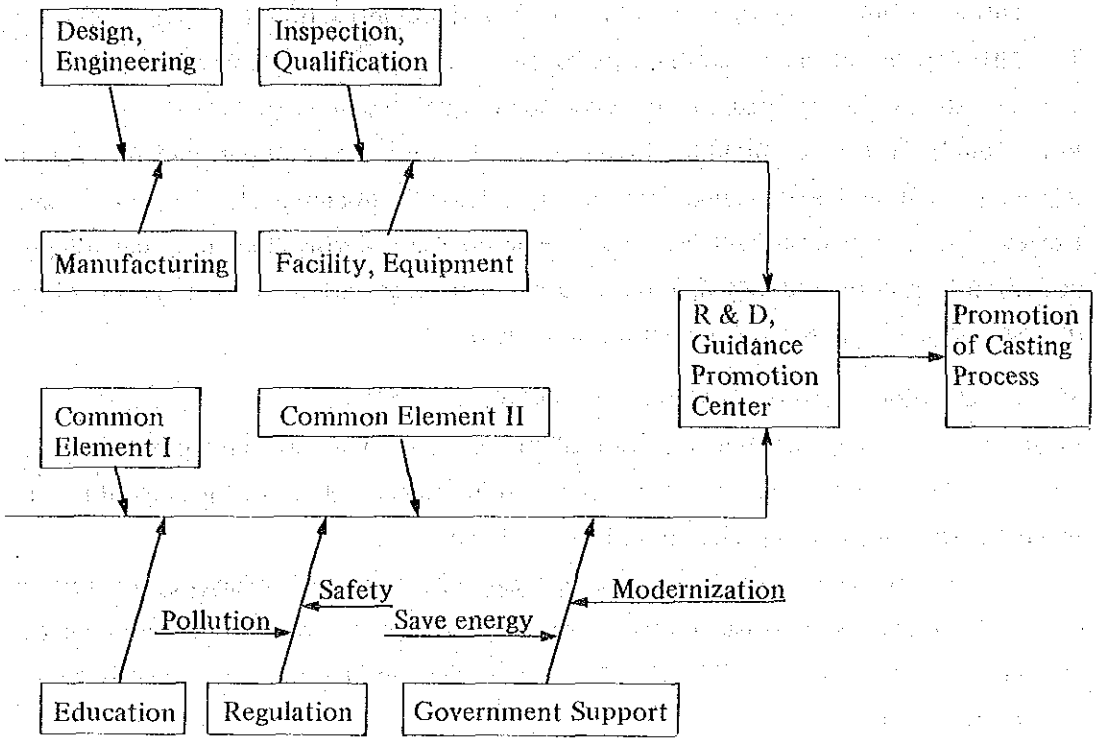


Fig. 4.5.1-22 Diagram on promotion of casting industry (Total system)

4.5.2 Forging

Twelve of 334 enterprises (i.e. 3.6%, and 5.1% of 235 companies who are subcontracted) to whom this research was made engage to some extent in forging. However, for most of them forging is one of their sideline productions, and only three of them replied to detailed questions on forging. Thus it seems to be rather difficult to analyze the result of the survey on the forging industry statistically. It will therefore be necessary to mention in addition to this the general manufacturing tendency referring to related code numbers of the questionaire in order to understand and find ways of resolving the problems concerned.

(1) Scale and Forms of Enterprises

1) Capital (Q-01-01-01)

The capital of approximately 80% of all the enterprises engaging in forging (10/12 companies) is ฿.1,000 x 10^3 or more, respectively. The capital amount may be considered unexpectedly large, probably because these enterprises are, as described above, producing several items including forgings.

2) Sales (Q-01-02-01)

Approximately 50% of the enterprises have yearly sales of ฿.4,000 x 10^3 or less, which seems too small in relation to the capital, while approximately 40% (5/12 companies) of the enterprises have yearly sales of ฿.4,000 to 16,000 x 10^3. It can be said that the forging industry, for a Thai industry, is fairly productive. Certainly, however, their sales are very poor in relation to Japanese enterprises, in the same personnel scale. ((Average sales per factory in Japan: Y420 million (Industrial Statistical Chart from MITI, 1980))

Fig. 4.5.2-1

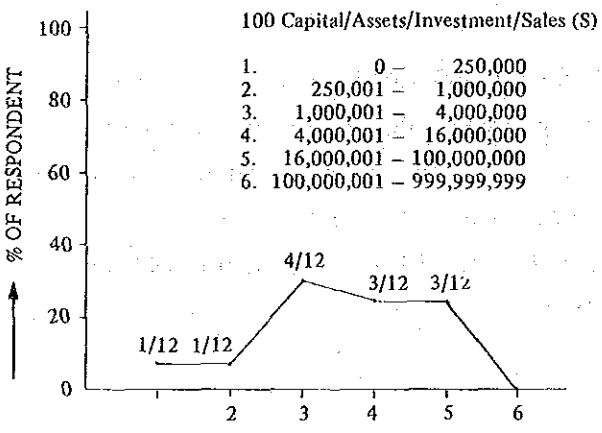
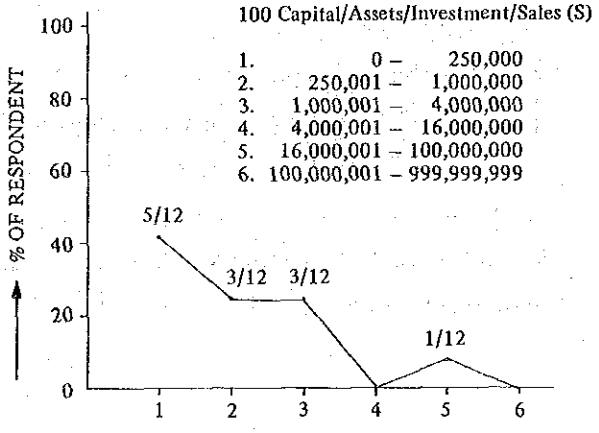


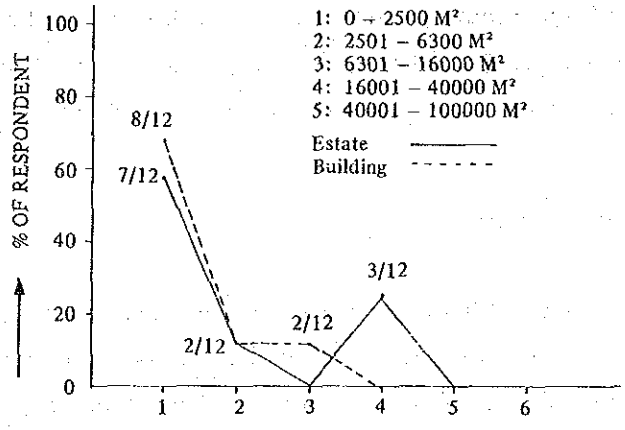
Fig. 4.5.2-2



3) Area of Site (Fig. 4.5.2-3)

Approximately 60% (9/12 companies) of the enterprises have a site of 2,500 M^2 or less, while 25% (3/12) have a site of 16,000 M^2 or more.

Fig. 4.5.2-3



4) Equipment Scale (Q-06)

Approximately 90% (11/12 companies) of the enterprises have equipment of only ฿.250 x 10^3 or less, which is too small in relation to the capital, probably because they use rather unexpensive primitive equipment.

Table 4.5.2-1

Q-06 Cost of equipment	%	Number of company
Less than ฿.250,000	91.7	11/12
฿.4,000,001 – ฿.16,000,000	8.3	1/12

5) Employees

a. Number of employees (Fig. 4.5.2-4 (Q-10-00-61)): 50% (6/12 companies) are enterprises with 50 employees or more, showing that the forging industry in Thailand includes many middle-sized enterprises. For the number of employees, forging enterprises in Thailand may equal to Japanese forging enterprises with 19.3 employees per factory according to MITI's Industrial Statistical Chart, 1980, (and with 11 to 20 employees who understand forging as shown in Fig. 4.5.2-5 (Q-231).

Fig. 4.5.2-4 Number of total employees

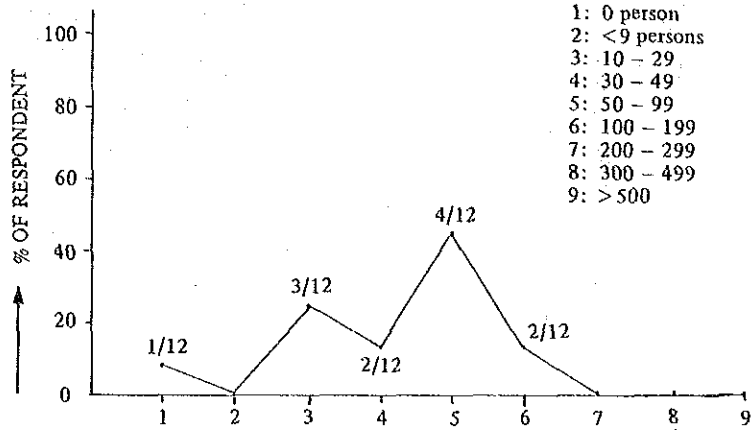
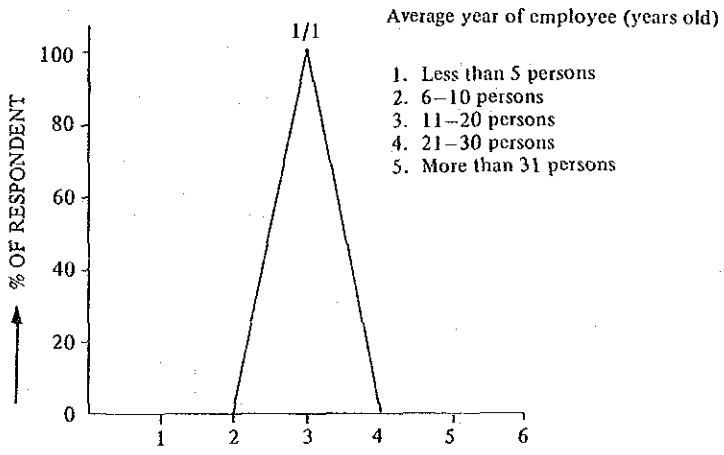


Fig. 4.5.2-5



b. Employees' years experience, wages, and education levels and training system: Average age of employees is very young. Most of the employees are 15 years old or younger (see Fig. 4.5.2-6 (Q-10-00-53)). Approximately 60% (5/9 companies) of the enterprises have 30% or fewer employees with experience of 5 years or more (Fig. 4.5.2-7 (Q-13-01)). For average wages, all employees get ฿1,000 or less per month.

For education level, most of the employees have no education of higher than primary level. The percentage of employees with education becomes proportionately lower at higher levels of education. (Fig. 4.5.2-8, 9 (Q-11-00-01, 02, 03, 04, 05, and 06)) Therefore, training should be planned effectively using peripatetic instruction, consultant service, seminar, curriculum, etc. according to the individual education level of employees.

Fig. 4.5.2-6

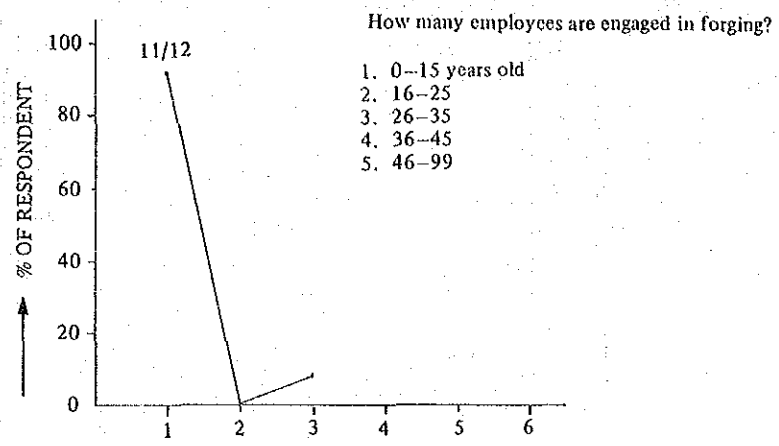


Fig. 4.5.2-7

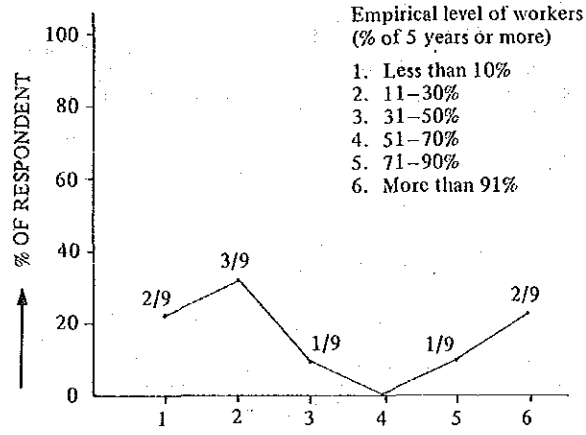


Fig. 4.5.2-8

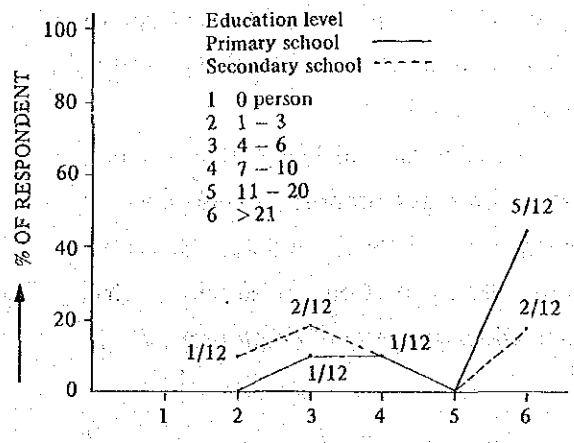
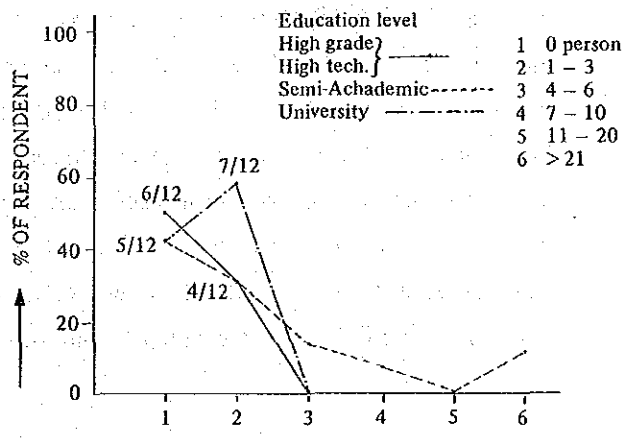


Fig. 4.5.2-9



c. Breakdown of employees (Fig. 4.5.2-10, 11, 12, 13 (Q-10-01-01, 02, 03, and 04)): Twenty to forty-four percent of the enterprises (2/10–3/10, 4/9 companies) do not have jobs in their organization such as marketing, cost estimation, inspection, and design engineering.

Fig. 4.5.2-10

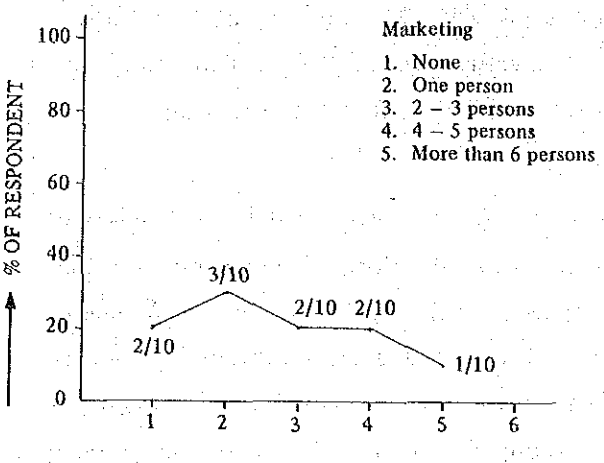


Fig. 4.5.2-11

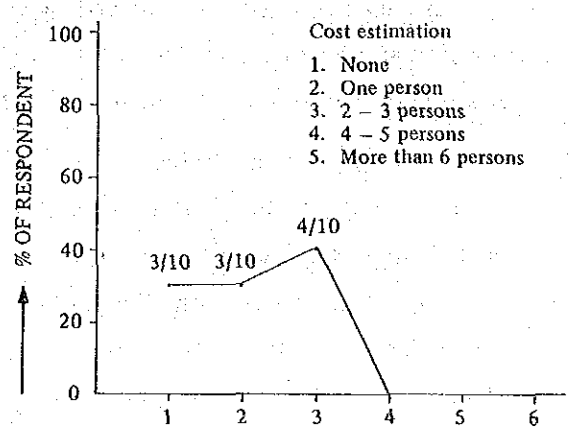


Fig. 4.5.2-12

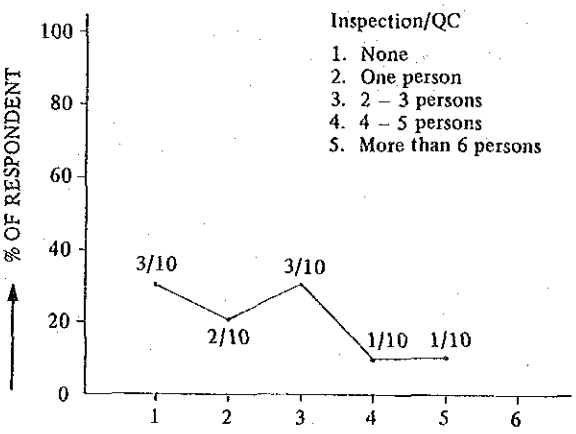
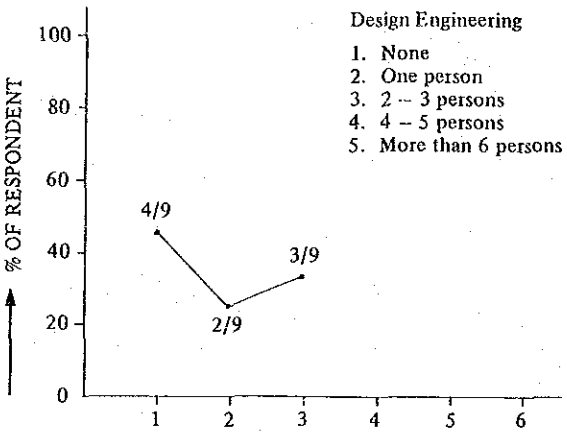


Fig. 4.5.2-13



6) Specialization percentage and kind of sideline products (Table 4.5.2-3, 4 (Q-05))

No enterprises responding to the survey are specialized exclusively in forging. Approximately 90% (11/12 companies) engage in forging which is 20% or less of their total product. Thus, forging has very low percentage of production in relation to other items in one enterprise.

Table 4.5.2-2

Rate of share %	%	Number of company
0 – 20	91.7	11/12
21 – 40	8.3	1/12

In sideline products, metal work stamping is the largest (5/7 companies for own use, and 3/7 for subcontracted-in), followed by metal mould (4/7 for own-use, and 1/10 for subcontracted-in) and platework welding (3/7 for own-use, and 3/10 for subcontracted-in), and the item most subcontracted out is heat treatment (4/4) followed by plating.

7) Kind of products (Table 4.5.2-3, 4 (Q-05))

Table 4.5.2-3, 4 shows kind of products made by enterprises which include forging in their line. Since very few enterprises replied to the questionaire, it is not easy to find any explicit tendency from the result. We can notice that the main items belonging to "Own-Use" or "Subcontracted-In" group are civil structural and constructural machinery or parts, agricultural machinery or parts, motor vehicles or parts, and transport and harbour equipment. Forgings may contain small stamp work and small free forgings (forging work).

Table 4.5.2-3

Q05 Kind of products Own use/Subcontracting out/ Subcontracted in: (M/A)

1.Own 2.In 3.Out

1. Motor vehicles or parts
2. Industrial machinery or parts
3. Civil structural & construction machinery or parts
4. Agricultural machinery or parts
5. Electrical & telecommunication machinery or parts
6. Transport & harbour equipment not classified elsewhere but including shipbuilding & repairing
7. Pipework or parts (except item 16)
8. Architectural/carpentry & building works or parts
9. Railway equipment & carriage parts
10. Working tools or parts
11. Metalworking machinery or parts (except item 17)
12. Moulds & dies or parts
13. Tableware/utensils or parts
14. Kitchen equipment
15. Engines & turbines
16. Pumps & valves
17. Machine tools
18. Gears
19. Other machineries & equipment or parts
20. Others, specify

Table 4.5.2-4

Ranking	Product	Own use
1	Civil structural & construction machinery	66.6% (2/3)
2	Transport & harbour equipment including shipbuilding & repairing	33.3% (1/3)
2	Pipework or parts	33.3% (1/3)
2	Metalworking machinery or parts	33.3% (1/3)
2	Mold & dies or parts	33.3% (1/3)
2	Machine tools	33.3% (1/3)

Ranking	Product	Subcontracting in
1	Agricultural machinery or parts	50.0% (3/6)
2	Motor vehicles or parts	33.3% (2/6)
2	Industrial machinery or parts	33.3% (2/6)
2	Civil structural & construction machinery or parts	33.3% (2/6)
2	Architectural/cirpentry & building works or parts	33.3% (2/6)
3	Transport & harbour equipment including shipbuilding & repairing	16.7% (1/6)

Subcontracting out; No company

Weight per piece of forgings is typically 1 to 3 kg as shown in Fig. 4.5.2-14 (Q-221). In Thailand most manufacturers would have the capacity of forging up to 10 kg. (according to Technonet Asia document).

8) Subcontractors

There are very few subcontractors in the forging industry except those subcontracting for heat treatment (2/12 companies) and plating (2/12) as shown in Fig. 4.5.2-15 (Q-31).

Fig. 4.5.2-14

Q221 What is the maximum weight of forging in one piece? (S)

1. Less than 1 kg
2. 1 – 3 kg
3. 3 – 5 kg
4. 5 – 10 kg
5. 10 – 30 kg
6. More than 30 kg

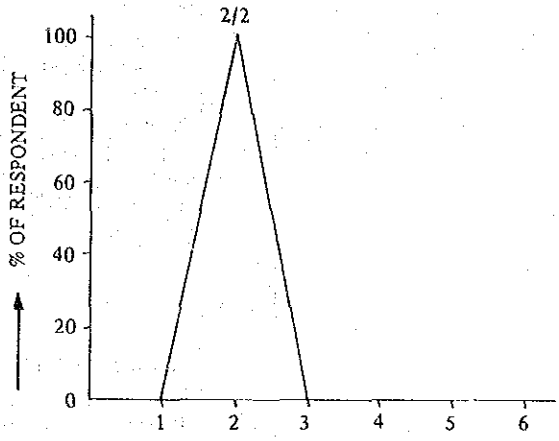
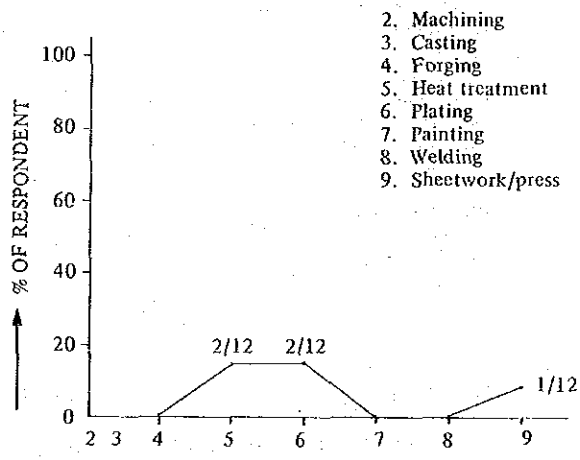


Fig. 4.5.2-15

Q31-1 Do you have subcontractor(s)? If yes, indicate the number and the share of payment by processes. (M/R)

	Numbers of sub-contractors	% of payment for the subcon-tractors jobs
Complete products	1.	11.
Parts, component & processing		
· Machining	2.	12.
· Casting	3.	13.
· Forging	4.	14.
· Heat Treatment	5.	15.
· Plating	6.	16.
· Painting	7.	17.
· Welding	8.	18.
· Sheet Work/ Pressing	9.	19.
Total:	10.	100%



(2) Equipment Owned and Forging Methods

1) Forging machines and forging methods (Fig. 4.5.2-16 (Q222))

The most common forging method is the machine hammer method (2/2 companies), and 66.7% by Technonet Asia document), and another method may be manual forging (33.3% by Technonet Asia document). Machine forging is suitable for producing forgings to be used for industrial purposes, as shown in type of products (See para. 7 Kind of products); they are civil structural machinery or parts, agricultural machinery or parts, motor vehicles or parts, and transport and harbour equipment or parts. Among the above, motor

vehicles or parts, agricultural machinery or parts, and bolts, nuts, joints, nails, etc. will be produced by stamping (e.g. Thai Forging Co.).

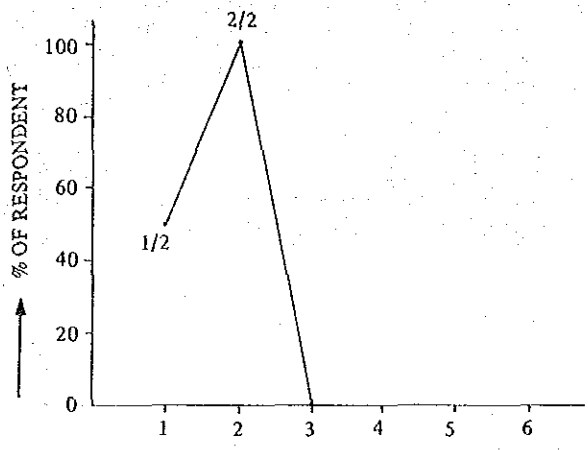
Manual forging may mainly produce everyday life utensils.

Average scale of installations of enterprises is small as shown in section (1)-4) Equipment scale.

Fig. 4.5.2-16

Q222 Specify your type of forging work? (M)

1. Hand forging
2. Free forging by mechanical hammer
3. Free forging by mechanical or hydraulic press
4. Die forging by boad hammer
5. Die forging by drop hammer
6. Die forging by mechanical or hydraulic press
7. Others - specify, ( )



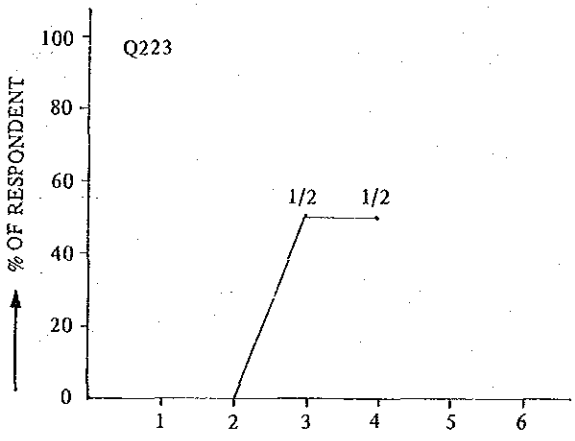
2) Capacity of forging machines (Fig. 4.5.2-17 (Q-223))

Capacity of forging machines in Thailand is also small, as shown in Fig. 4.5.2-17 (Q-223); the main type of the machine is the hammer of no more than 3 tons capacity which is capable of producing forgings of 1 to 3 kg (up to 10 kg) (See Fig. 4.5.2-14 (Q-221)) and this is endorsed by Technonet Asia document.

Fig. 4.5.2-17

Specify the maximum capacity of hammer/press used? (S)

1. Hammer power
2. Below 1/4 ton
3. 1/4 – 1 ton
4. Above 1 ton



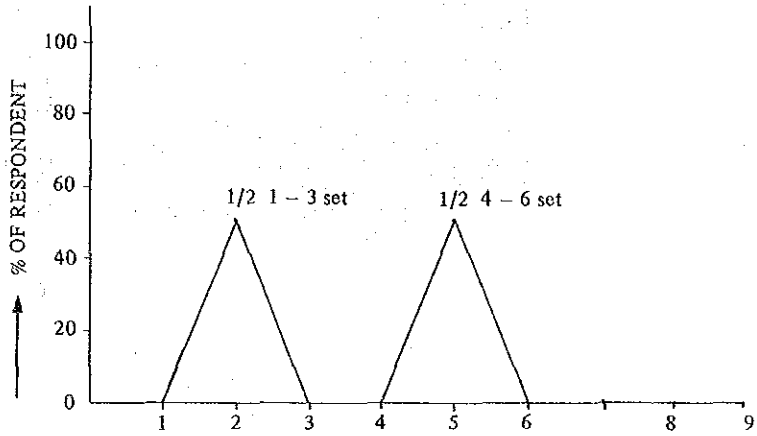
3) Furnace

Fig. 4.5.2-18 (Q-225) shows the kind and number of furnaces for forging. The most popular kind of furnace is the oil furnace of box-batch type.

Fig. 4.5.2-18

Q225 What is the capacity and number of heating furnace or oven or heating furnace? (M, R) Number (set)

1. Cokes oven
2. Coal oven _____ 1 ~ 3 set
3. Charcoal oven
4. Coke/coal heating furnace
5. Oil heating furnace _____ 4 ~ 6 set
6. Gas heating furnace
7. Electric resistance heating furnace
8. Electric induction heating furnace
9. Others specify



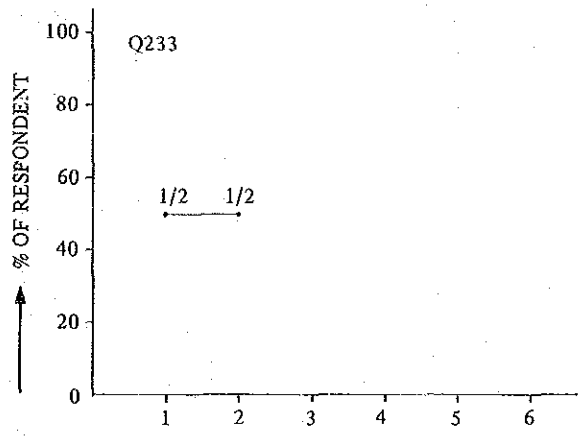
4) Mould for stamp forging

Moulds are either made in Thailand or imported, as shown in Fig. 4.5.2-19 (Q-233). Some enterprises such as Thai Forging Co. engage in design, machine work, and making moulds. In this case, however, they have to import raw material of steel and subcontract heat treatment in Thailand. It is perhaps a problem for them that raw material of steel should be imported not only for forging moulds, but also for plastic injection moulds and metal press work moulds in some cases.

Fig. 4.5.2-19

Q233 Which is your metal mold in die forging domestic or imported? (S)

1. Imported
2. Domestic



(3) Production, Production engineering and quality control

This section describes production, production engineering and quality control over several kinds of products including forgings as common topics, taking the result of field survey into consideration, because most enterprises have a forging department only as one of their production departments and only few replied on the detailed contents of forging.

1) Monthly production capacity (Fig. 4.5.2-20, Table 4.5.2-5 (Q30/234))

Approximately 60% (7/12 companies) of the enterprises have monthly production of 1,500 pcs. per month or more, while one-third (4/12) produce only 150 pcs. per month. It seems that two-thirds of the enterprises have a mass production system, i.e. stamp forging, and the remaining one-third operate with a free forging system. For weight, 1,000 kg/month (Table 4.5.2-5 (Q-234)) is dominant, while some enterprises produce 4 tons/month with a free forging system.

Fig. 4.5.2-20

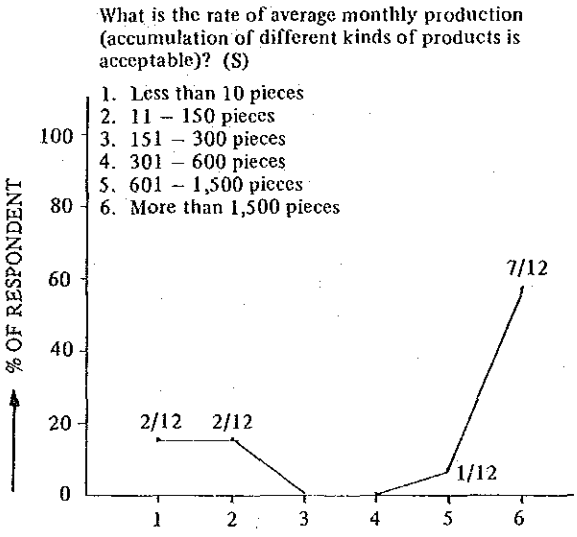
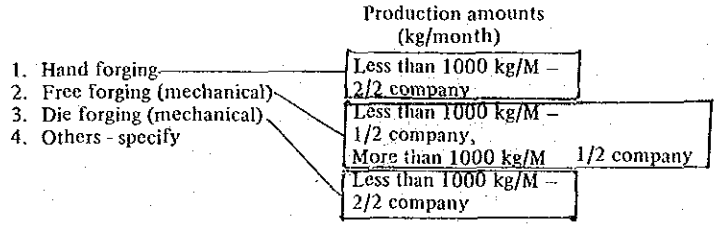


Table 4.5.2-5 (Q234)



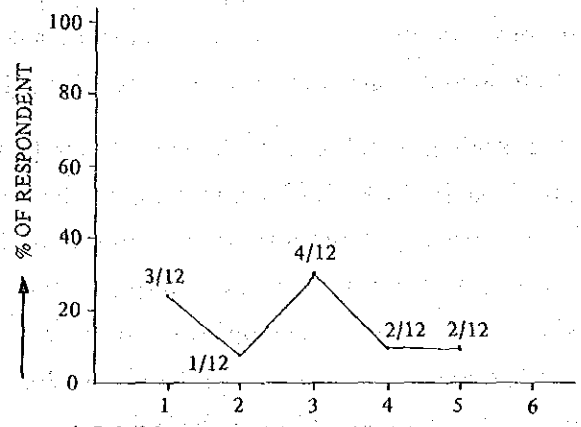
2) Employees capable of reading a technical drawing Fig. 4.5.2-21 (Q-41)

Two-thirds (8/12 companies) of the enterprises have two to four employees who have enough knowledge to read technical drawings, while one-fourth (3/12) have none. There seems to be urgent need to increase the number of employees who understand technical drawings in order to raise the technical level. For that purpose, it is required to have governmental assistance of educating labourers, as enterprises themselves expect, as shown in Table 4.5.2-12 (Q-74).

Fig. 4.5.2-21

Q41 How many employees can understand the technical drawings? (S)

1. None
2. One person
3. 2 – 4 persons
4. 5 – 10 persons
5. More than 10 persons



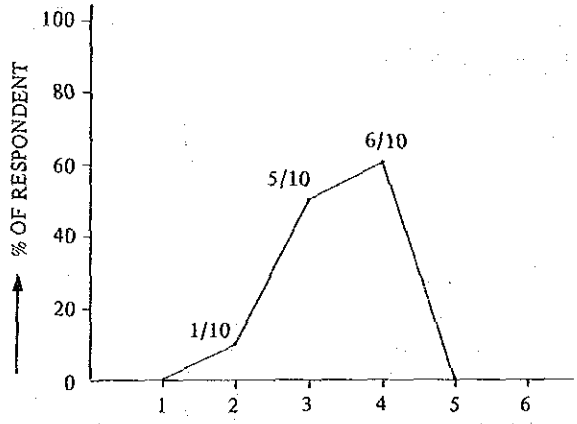
3) Dimensional accuracy of products Fig. 4.5.2-22 (Q-43)

The Fig. 4.5.2-22 shows that six companies of ten have an accuracy of 1/10 mm and five of ten have an accuracy of 1 mm. This level of accuracy probably applies to stamp.

Fig. 4.5.2-22

Q43 What is the tolerance of your main products? (M)

1. 100 mm or rough estimate
2. 10 mm
3. 1 mm
4. 1/10 mm
5. 1/100 mm
6. Less than 1/100 mm



4) Measuring and inspection equipment (Table 4.5.2-6 (Q-42))

a. Measuring equipment: The measuring equipment here includes vernier caliper (9/12 companies), tape measure (8/12), caliper (7/12), steel ruler (7/12), micrometer (7/12), voltmeter, ammeter (6/12), and square (5/12). Some enterprises have such equipment, but some others do not have all of it. We really wonder how the latter operate forging successfully. Enterprises should at least use equipment like the above as the minimum requirement.

b. Inspection equipment: No responding enterprises have any inspection equipment as shown in Table 4.5.2-6 (Q-42). Here there seems also to be an urgent need for at least simple inspection equipment. It might be suggested that some expensive sophisticated inspection equipment is prepared by the government for common use among enterprises. The machines in question are chemical analytic equipment, metal material testing machines, and non-destructive inspection machines.

Table 4.5.2-6 (Q42)

Q42 What kind of measuring tools does your factory use? (M)

	Number of firms
Length/Flatness	
1. Tape measure	8/12
2. Carpenter ruler	
3. Steel ruler	7/12
4. Caliper	7/12
5. Varier caliper	9/12
6. Micrometer	7/12
7. Depth meter	
8. Dial gauge	
9. Cylinder gauge	
10. Optimeter	
11. Microscope	
12. Thickness caliper	
13. Precision level	
14. Special purpose gauge (jig)	
15. Thickness gauge	
Angle/Squareness/Parallelism	
21. Angle plate	
22. Steel protoractor	
23. Universal benel protoractor	
24. Square	5/12
25. Straight edge	
26. Combination square set	
27. Micro protoractor	
28. Optical protoractor	
29. Iron level	
30. Precision level	
31. Box precision level	
Profile	
32. Radius gauge	
33. Screw pitch gauge	
34. Taper gauge	
35. Drill gauge	
36. Gear tooth gauge	
37. Projector	
38. Roundness tester	
Temperature	
41. Etched-stem thermometer	
42. Thermo-electric thermometer	
43. Registance thermometer	
44. Optical pyrometer	
45. Surface thermometer	
46. Temperature recorder	
47. Immersion pyrometer	
Hardness	
51. Brinell tester	
52. Vickers tester	
53. Rockwell tester	
54. Shore tester	
55. Harnester	
Machined surface roughness	
61. Standard piece for surface roughness (Surface roughness scale)	
62. Optical roughness tester	
63. Electrical roughness tester	
64. Interference roughness tester	
65. Surface measuring instrument	
Electric performance testing	
71. Wattmeter	
72. Voltmeter	7/12
73. Ammeter	6/12
74. Power factor meter	
75. Torque meter	
76. Insulation resistance meter	
Testing	
81. Colour checker	
82. Magna flux tester	
83. Ultra sonic tester	
84. Tensile strength tester	
85. Chemical analyser	
86. Tachometer	
87. Stop watch	
88. Dynamometer	
89. Noise meter	
90. Vibrometer	
91. Stroboscope	
Miscellaneous	
95. Surface plate	
96. V-block	
97. Magnetic V-block	
98. Surface gauge	

Notice: Item of no number is no answer.

5) Trends of standards and/or specifications (Q-44)

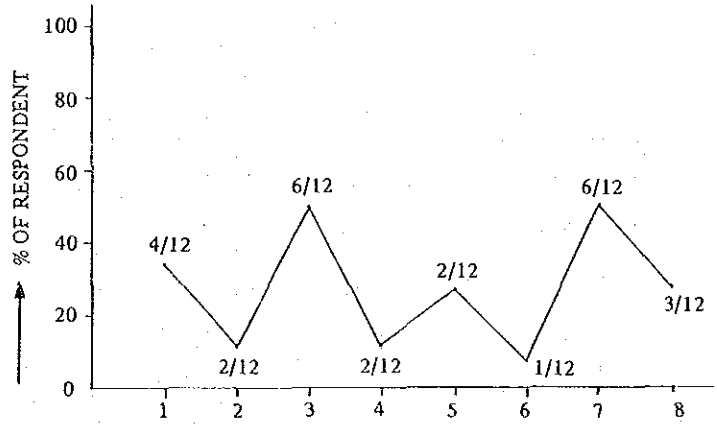
Most enterprises apply JIS and clients' standards (each 50%, 6/12 companies), followed by ASTM, DIN, and own standards (25%, 3/12).

If these standards are complied with as they are, there will be no problems at all. Further study should be made with governmental support on the actual state of compliance.

Fig. 4.5.2-23

Q44 What kind of industrial standards do you use? (S/A)

1. ASTM
2. BS
3. JIS
4. ISO
5. DIN
6. TIS
7. Customer's std.
8. Own std.



6) Costs for research and development (Fig. 4.5.2-24 (Q-45-01))

Ninety percent of the enterprises (7/10 companies) spend 1% or less of their sales on research and development. However, 60% (6/10) of them do not have a budget for research and development. The enterprises need and hope for governmental assistance for improving the situation.

7) Quality control system

a. Inspection system (Fig. 4.5.2-25 (Q-46-01)): Many of the enterprises employ first inspection (7/12 companies) and sampling test (9/12) system, as shown in Fig. 4.5.2-25

Fig. 4.5.2-24

Q45-1 How much to the sales do you spend on research and development? (S)

1. None
2. Less than 0.5%
3. 0.6% – 1%
4. 1.1% – 2%
5. 2.1% – 3%
6. More than 3%

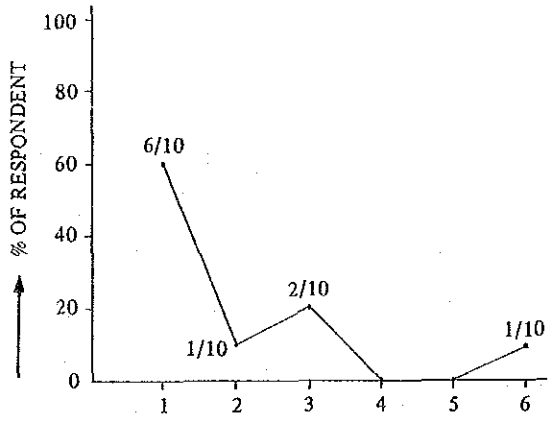
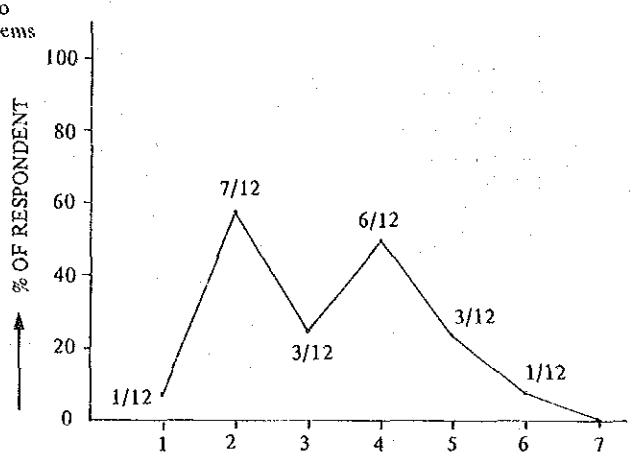


Fig. 4.5.2-25

Q46-1 Please give informations on your quality contro system, i.e. the inspection systems, checking items and the feed back system. (M)

The inspection system is (are):

1. Systematic inspections are not available, "When trouble cocurs check"
2. First articles inspection
3. Single sampling inspection
4. Multiple sampling inspection
5. Sequantial sampling inspection
6. Total (100%) inspection
7. Without acceptance or purchasing inspection
8. With acceptance or purchasing inspection by standard inspection documents

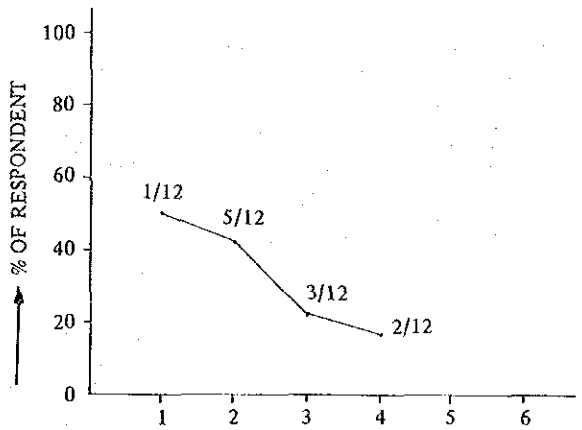


b. Inspector (Fig.4.5.2-26 (Q-46-01-01)): Inspection is done by either operators (6/12) themselves or supervisors (5/12 and 3/12). It will be no surprise how high the defective rate is in this field, as shown in Fig. 4.5.2-33 (2% or more for 6/9 companies). Training and education are needed urgently here, too.

Fig. 4.5.2-26

Whom is it inspected by?

1. Workers themselves
2. Manager or the owner
3. Professional staff, patrol
4. Professional staff, stationary

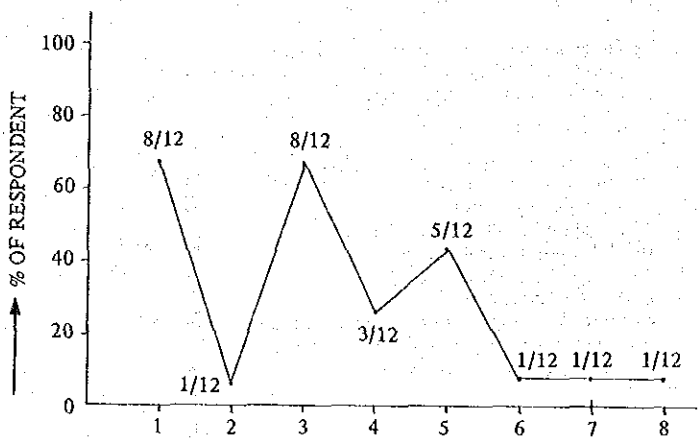


c. Checking methods (Fig. 4.5.2-27 (Q-46-01-01)): Dominant checking methods are visual inspection, size inspection, hardness inspection, etc. (8/12 companies, 8/12, and 5/12, respectively). The enterprises do not perform any non-destructive inspection naturally because there are no non-destructive inspection machines in the Thai forging industry. Some urgent support for improvement should be given by the government.

Fig. 4.5.2-27

Checking methods and items are:

1. Visual check
2. Sensory check
3. Dimensional check
4. Clearance check for moving parts
5. Hardness check
6. Surface roughness check
7. Colour check
8. X-ray check
9. Magna flux check
10. Noise check
11. Vibration check
12. Life test/running test



d. Feedback method (Fig. 4.5.2-28 (Q-46-01-01))

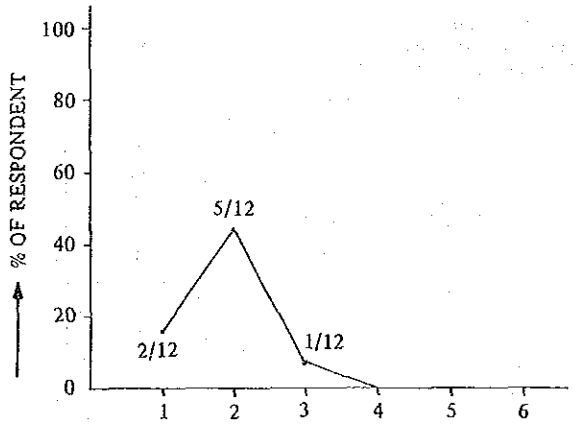
Five companies out of twelve employ the circulating notice system, while two out of twelve have/no feedback system at all.

No enterprises seem to have a plan for active settlement of the problems by themselves. They will have to learn what correct quality control is.

Fig. 4.5.2-28

Feedbacked of the results of inspection is:

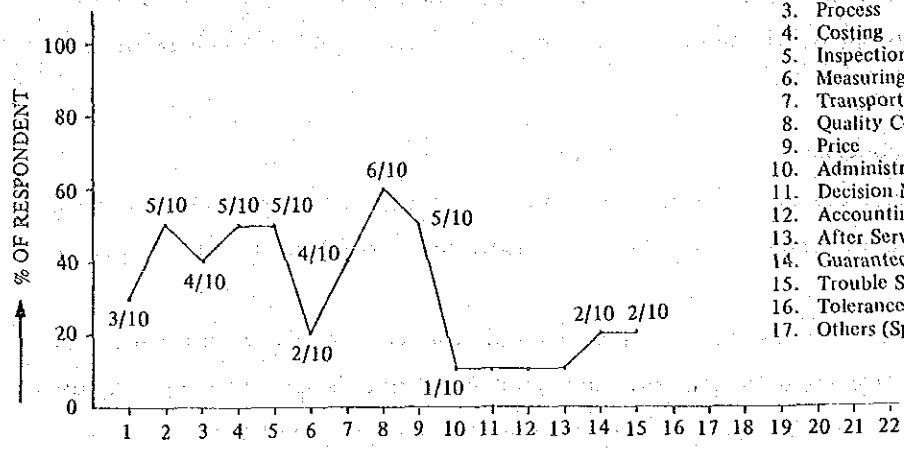
1. Only in file, no feedback
2. Notice on the boad
3. Circulating notice or inspection record to workers/managers
4. Establishing counter measures by workers/managers
5. Establishing counter measures by professional staff, statistical quality control system



8) Standardization level (Fig. 4.5.2-29 (Q-49-01))

Standardization level is attempted in quality control (6/10 companies) followed by production (5/10), cost (5/10), testing and inspection (5/10), and price (5/10), and by manufacturing process (4/10). However, guarantee, design making and after-sales-service levels stay low, which may be a problem to be settled in future.

Fig. 4.5.2-29



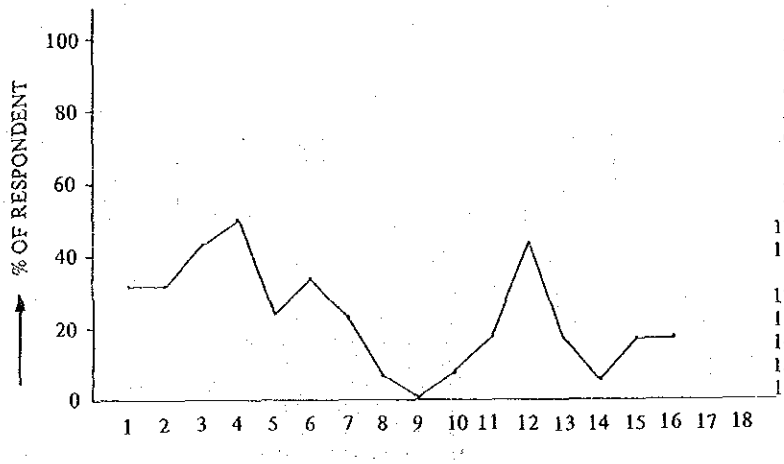
Q49-1 Standardization level (Please specify appropriate items of your firm) (M/A)

1. Design
2. Production/Works
3. Process
4. Costing
5. Inspection/Testing
6. Measuring
7. Transportation
8. Quality Control
9. Price
10. Administration
11. Decision Making
12. Accounting
13. After Services
14. Guarantee
15. Trouble Shooting
16. Tolerance
17. Others (Specify)

9) Sources of technical information and/or knowhow (Fig. 4.5.2-30 (Q-49-04))

Prevailing sources are seminars (6/12 companies), magazines (5/12), human network (5/12), newspapers (4/12), and exhibitions 4/12), while ISI ( ), peripatetic instructors, and colleges have only little influence on the industry. Governmental support in this part is also much required and expected by enterprises, as shown in Table 4.5.2-12 (Q-74).

Fig. 4.5.2-30



Q49-4 Sources of technical information (M/A)

1. Newspaper
2. Magazine (Local)
3. Magazine (Foreign)
4. Seminar
5. Workshop
6. Exhibition
7. Consultant
8. extension officer
9. Circular
10. Corporative
11. Industrial service institute (ISI) of DIP
12. Human network
13. Subcontractor
14. Other firms
15. University/college
16. Others (Specify)

10) Shipment inspection (Fig. 4.5.2-31 (Q-49-07))

Three companies out of nine have their subcontractor's staff perform inspection before shipment, and surprisingly three out of nine do not perform inspection before shipment. Enterprises should consider how they include inspection before shipment into their quality control system by themselves, however, governmental guidance will be of great help to them.

11) Inspection records (Fig. 4.5.2-32 (Q-49-08))

Some enterprises make visual inspection records (4/11) and size inspection records (4/11), while four out of eleven do not have any inspection at all. The situation needs urgent improvement.

Only three companies out of eleven make material test records. The record should be made in more enterprises with assistance and guidance from the government. The use of public instruments may be one of the effective methods for improvement.

Only one out of eleven has a heat treatment record, and it is natural that non non-destructive inspection is done. This kind of inspection will require urgent support and guidance from the government, too.

Fig. 4.5.2-31

Q49-7 Shipping inspection system (For subcontracted goods) (S/A)

1. None
2. Permanent check by subcontractor's staff before delivery
3. Temporary check by subcontractor's staff before delivery
4. Visual check after delivery
5. Inspection records check after delivery
6. Self-management of subcontractee
7. Others (Specify)

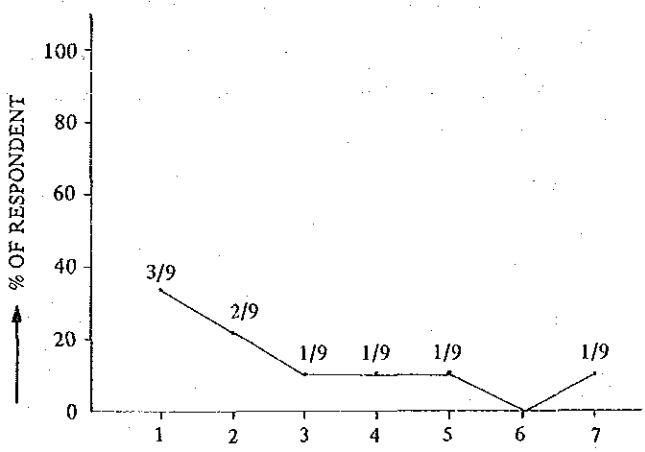
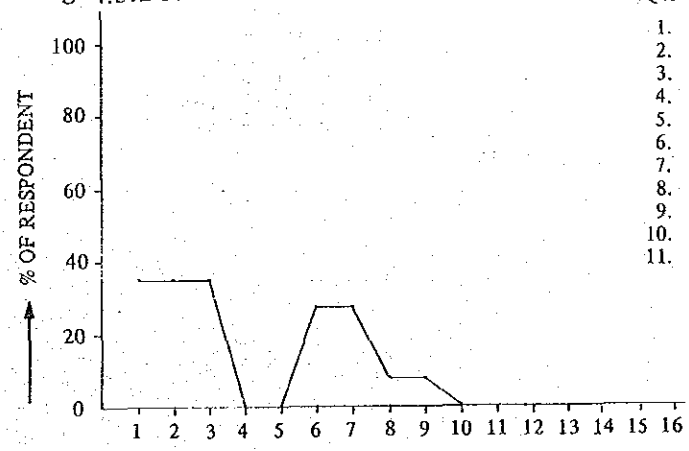


Fig. 4.5.2-32

Q49-6 Inspection records (M/A)

1. Nothing
2. Visual inspection records
3. Dimension check records
4. Colour check records
5. X-ray, ultrasonic, magna-flux test records
6. Material test records
7. Material analysis records
8. Heat treatment records
9. Statical operation test records
10. Dynamical operation test records
11. Others (Specify)



12) Defective rate (Fig. 4.5.2-33 (Q-49-09))

Defective rate after shipment is high; three of nine have a rate of 6 to 10%, three of nine 2 to 5%, and three out of nine 1% or less. The enterprises will have to restart at the fundamentals of quality control. (1/2 company has 2 to 5% defective forgings shown in Table 4.5.2-7 (Q235)

Fig. 4.5.2-33

Q49-9 Defect rate after shipping (S)

1. More than 30%
2. 21 – 30%
3. 11 – 20%
4. 6 – 10%
5. 2 – 5%
6. Below 1%

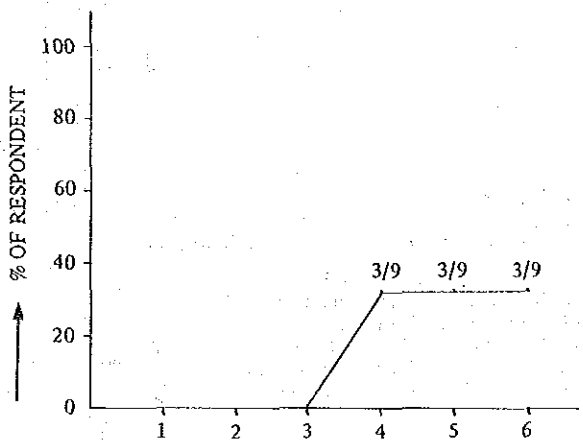


Table 4.5.2-7 (Q235).

What is the rejected ratio of your forging products?

1. Less than 1% 1/2 company
2. 2 – 5% 1/2 company
3. 6 – 10%
4. 11 – 30%
5. Above 31%

13) Defective control (Fig. 4.5.2-34 (Q-49-10))

Investigation of defects is performed empirically (4/9 companies) or in general analysis (3/9).

However almost none of the enterprises performs individual analysis or analysis for each product in process. Enterprises should review their quality control methods from the beginning, and for employees' education governmental support and guidance are quite urgent.

14) Enterprises' technical levels evaluated through interview (Fig. 4.5.2-35 (Q-49-13))

Six of eleven companies are evaluated as "local level" companies. In order to improve the situation up to the "national level", as is quite preferred, the government should play a very important role.

Fig. 4.5.2-34

Q49-10 Defect management system (S/A)

1. Not applicable
2. Emprically
3. Analysis of causes as a whole
4. 3. + their monetary terms conversion
5. 4. either for each kind of product or process
6. 4. both for each kind of product & process
7. Others (Specify)

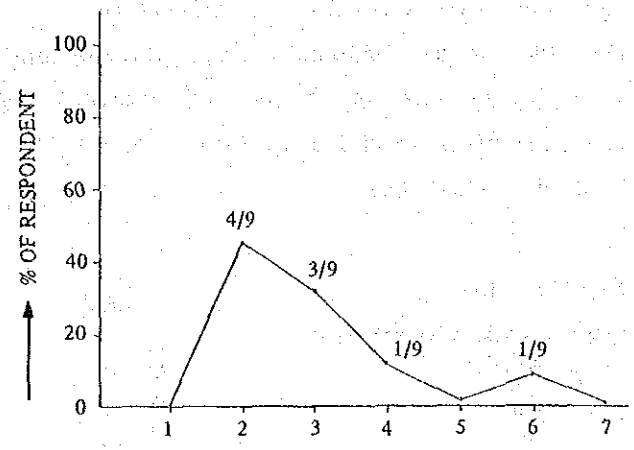
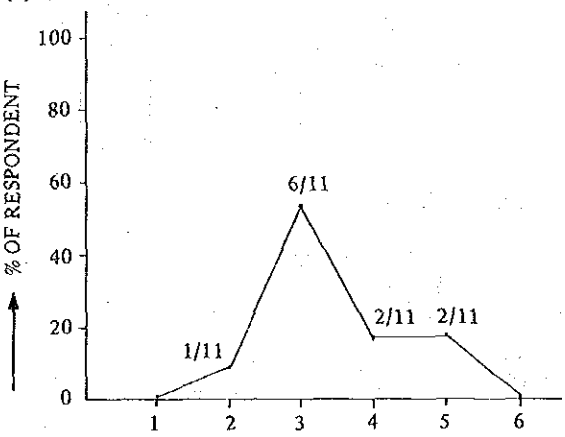


Fig. 4.5.2-35

Q49-13 Interviewer's assessment of technical level (S)

1. Very low (Primitive level)
2. Relativery low (Traditional level)
3. Normal/Average (Local level)
4. Relatively high (National level)
5. High (International level)
6. Extremely high (Exportable level)



(4) Raw Materials and Fuel

With the forging industry, raw materials and fuel should be considered because they are important elements in production. They are also important for saving resources and energy. You will recognize this by Fig. 4.5.2-44 (Q73) in which Material cost comes in second among management policies to be developed. (5/9 companies)

1) Raw materials (Fig. 4.5.2-36, 37, 38 (Q211, 212, 214))

Carbon steel barg and billets are used as forging materials. Some companies use scraps. (Fig. 4.5.2-36 (Q-211)) All of them are importations. (Fig. 4.5.2-37 (Q212)) Although the materials are identified by the standard materials such as JIS (2/2 companies), the materials supplied from customers or the materials with mill sheets are also used. (Fig. 4.5.2-38 (Q214)) But on-site inspection indicates that the machine parts which must be forged (for example, crankshaft of press) are sometimes cut out of thick round bars, causing many troubles.

a. Because of the machining out of thick round bars, the materials are poorly made. Their careless forging flow makes the quality of products poor even if the raw materials are standard ones. In other words, the good parts of the materials are cut out, while the bad parts are made into products. It becomes a big question about quality control. To solve this problem, their products have to be changed into the ones made by forging machines.

b. Taking the material yield into considerations, the material cost is very high because only less than 50% of raw materials are used (sometimes less than 30%). More than that, the round bars are importations. Consequently the cost rises high. To solve such problems, forging industry should be promoted in Thailand. Since labor cost is low in this country, they can produce high-quality high-yield forging goods by relative small forging machines. From this point of view, the promotion of the forging industry is required in Thailand and there is much potential for it.

Fig. 4.5.2-36 (Q211)

Q211 What kind of material is used in forging? (M)

1. Scrap
2. Ingot
3. Carbon steel bar or billet
4. Alloy steel bar or billet
5. Stainless steel bar or billet
6. Others - specify ( )

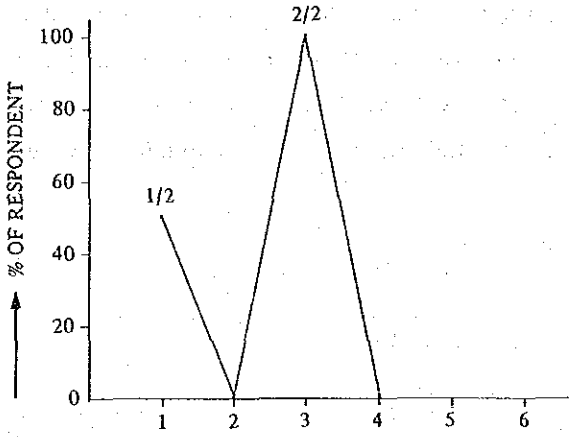


Fig. 4.5.2-37 (Q212)

Q212 How do you get raw materials and fules? (M, R)

	1.Domestic	2. Imported
1. Scrap ingot		1/2 company
2. Bar or Billet		1/2 company
3. Others		
4. Cokes		
5. Coal		
6. Charcoal		
7. Oil	1/1 company	
8. Gas		
9. Electric		
10. Others - specify		

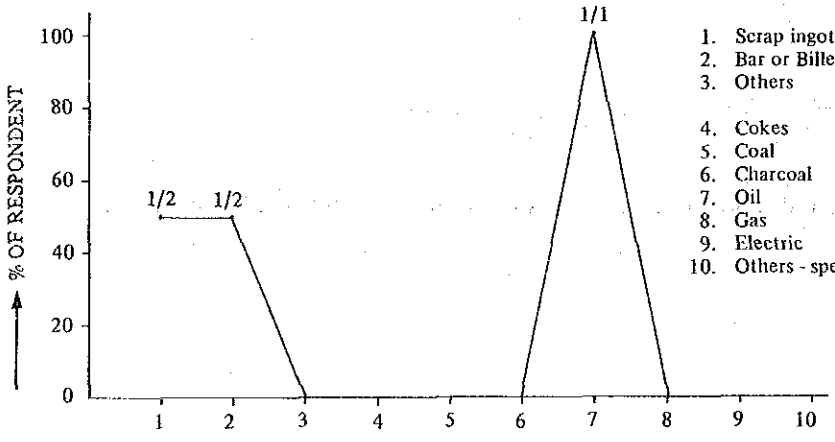
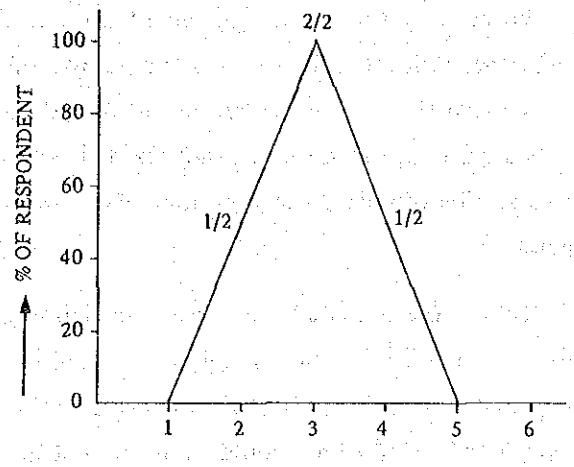


Fig. 4.5.2-38

Q214 Are the characteristics of raw materials identified? (S)

1. Not clear
2. Customer supply
3. Standard such as JIS, ASTM, SAE, BSS, DIN, AISI, ETC.
4. Certificated with mill sheet including chemical composition and mechanical properties
5. Others - specify, ( )

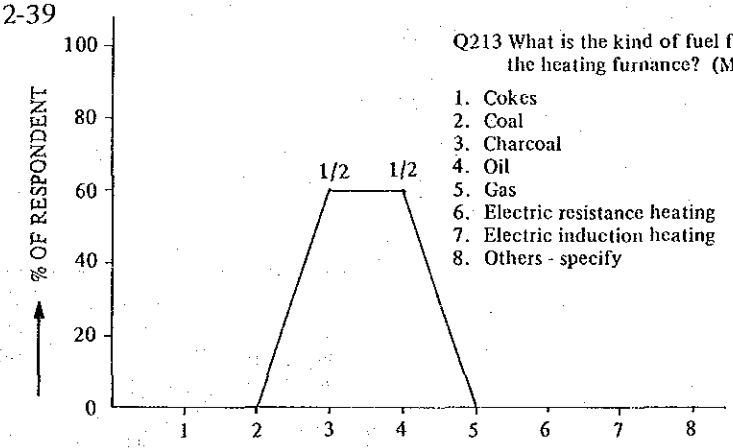


Metal molds for stamp forging are all importations. It will be a problem in the future on materials in Thailand as well as metal molds for plastics and metal press. It is concerned with the promotion of electric steel industry.

2) Fuel (Fig. 4.5.2-39 (Q-213))

Petroleum, coke, charcoal, and etc., are materials for forging furnace. Since most of them are imported from foreign countries and they cost so high, the utilization of domestic natural gas is expected in the future. The exploitation of natural gas is desirable because gaseous fuel does not generate much smoke and poisonous gas.

Fig. 4.5.2-39



Q213 What is the kind of fuel for heating furnace or oven or the heating furnance? (M)

1. Cokes
2. Coal
3. Charcoal
4. Oil
5. Gas
6. Electric resistance heating
7. Electric induction heating
8. Others - specify

(5) Markets/demand/prices

We will analyze market, demand, and prices or the forging industry by picking up from the small data.

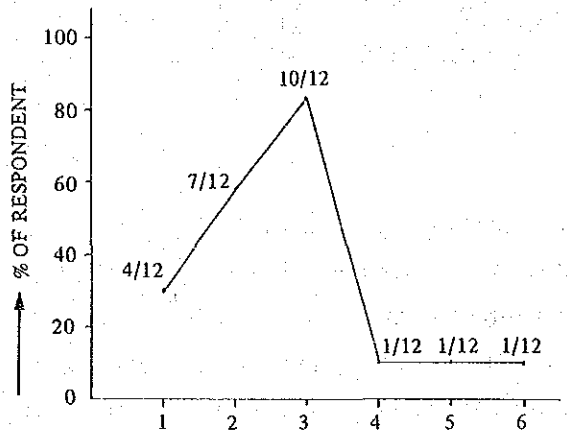
1) Market area (Fig. 4.5.2-40 (Q-20))

Most enterprises have domestic markets (10/12 companies) 7/12 companies have local markets. But the notable fact is that each one out of twelve companies is exporting their products to developing countries, NICS and advanced countries.

Fig. 4.5.2-40

Q20 Where are your products sold and consumed? (M)

1. Region/District
2. Province/State
3. Country
4. Developing countries
5. Newly industrialized countries (NICS)
6. Developed countries



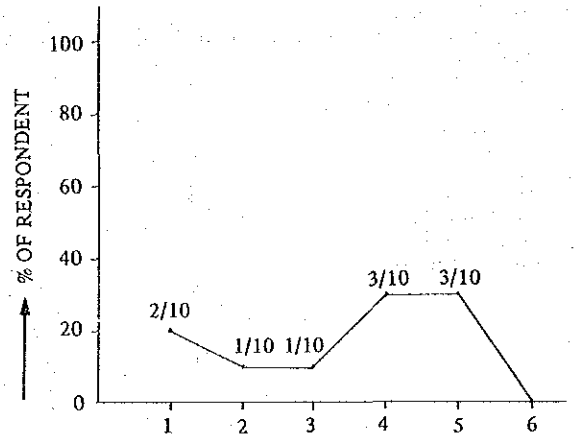
2) Back orders (Fig. 4.5.2-41 (Q22))

30% of the companies (3/10 companies) have back orders for more than a month, and the remaining 70% have back orders for less than one month. They have little back orders.

Fig. 4.5.2-41

Q22-1 How much of production orders do you have in hand? (S)

1. Non
2. One week or less
3. 8 – 15 days
4. 16 – 30 days
5. 1 – 5 months
6. More than 5 months



3) Price competetiveness (Table 4.5.2-8, Table 4.5.2-9 (Q-24, Q28))

More than 50% of the companies sell at market price (about 55%, 6/11 companies), and about 30% sell at cheaper price. (3/11 companies) About 55% of the companies have moderate competitiveness in market (6/11 companies), and about 36% have strong – very strong competitiveness. (4/11 companies)

Table 4.5.2-8

Q24 Assessment of price: Price level (s)
(Criteria = Market price)

	Number of firm	%
1. 31% and above higher		
2. 21% – 30% higher		
3. 11% – 20% higher		
4. 1% – 10% higher	2/11	18.2
5. Market price	6/11	54.5
6. Less than market price	3/11	27.3

Table 4.5.2-9

Q28 What is the present position of the firm in its own market?
How does it compare with its competitors? (S)

1. Very strong
2. Strong
3. Moderate
4. Weak
5. Very weak

	Number of firm	%
1:	1/11	9.1
2:	3/11	27.3
3:	6/11	54.5
4:	1/11	9.1

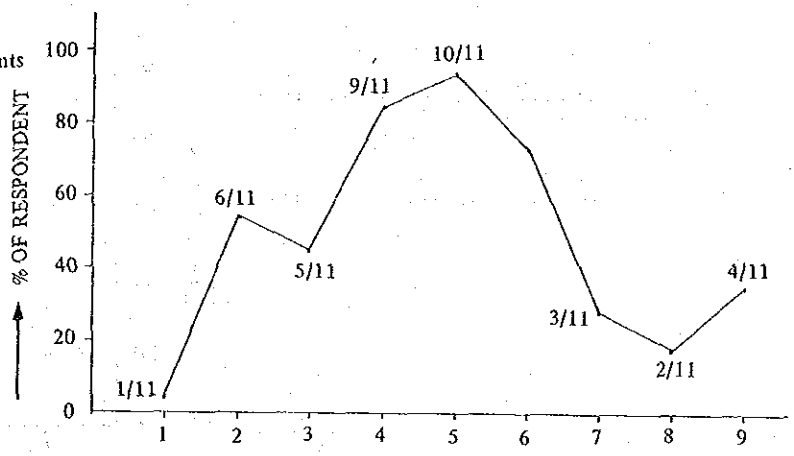
4) Cost control (Fig. 4.5.2-42 (Q23))

Most companies control labor cost (10/11 companies), material cost (9/11 companies), and direct – indirect cost (8/11 companies). About 50% of them, however, control all products and parts, and less than 50% calculate sales charge and profit cost. There are fewer companies considering writing-off. Therefore, the betterment of their cost control is greatly desirable.

Fig. 4.5.2-42

Q23 Break down of Costing/Accounting System (M/A)

1. None
2. Every kinds of products
3. Every kinds of parts and compartments
4. Material cost
5. Labour cost
6. Direct cost/indirect cost
7. Overhead
8. Sales charge
9. Profit
10. Depreciation
11. Fixed cost
12. Variable cost
13. Others (Specify)



5) Market survey (Table 4.5.2-10 (Q-29))

As is know from Table 4.5.2-10 (Q-29), 66.7 – 83.3% of the companies make survey into competitors, selling price, purchasing price of raw materials and quality. Survey on new technology and subcontract, and demand forecasting are seldom made. From this point of view, public organ's aid is necessary for collecting information.

Table 4.5.2-10 (Q29)

	Categories	%	Number of company
1	Competitors	66.7	4/6
2	Selling price	66.7	4/6
3	Purchasing price of raw materials key parts	66.7	4/6
4	Quality	83.3	5/6
5	Subcontractors	16.7	1/6
6	New technologies	16.7	1/6
7	Total demand	16.7	1/6

(6) Management and control

This section describes the existing condition that we researched and their hopes for the future policies as follows. Important elements are epitomized in them.

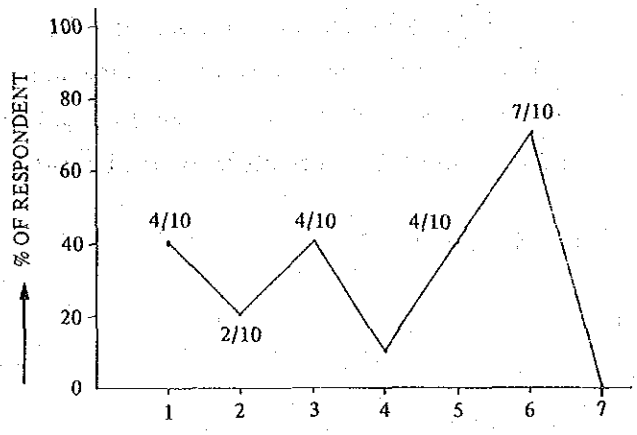
1) Profit control system (Fig. 4.5.2-43 (Q71))

70% of the companies cast profit and loss account. (7/10 companies) The rate of the companies doing break-even analysis is 40% (4/10 companies), and that of the companies calculating concerning each product is 40%. (4/10 companies) These percentages may be relative high, but they should be more increased.

Fig. 4.5.2-43

Q71 Profit management system (M/A)

1. Check as a whole business
2. Every business for main products
3. Every business for each products
4. Deference between standard cost & actual cost
5. Break even point
6. Profit & loss calculation/account
7. Others (Specify)



2) Managerial policy for the future (Table 4.5.2-11, Fig. 4.5.2-44 (Q73))

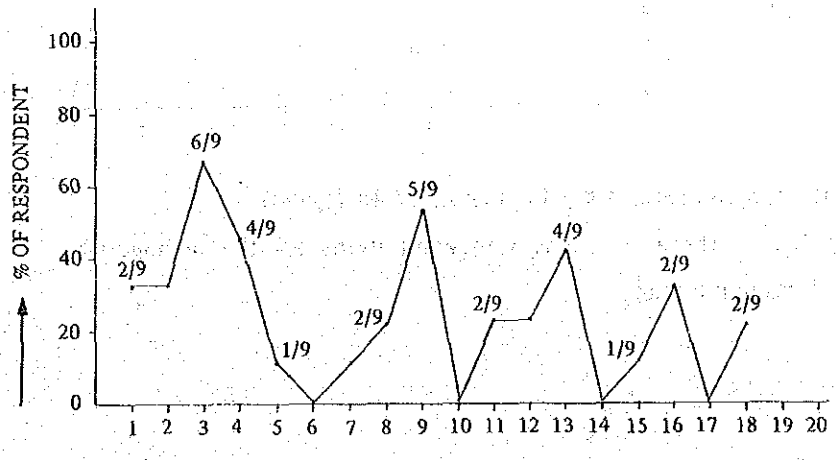
As is shown by the figure below, there are many important items for the managerial policy for the future of the forging industry.

Table 4.5.2-11 (Q73) Managerial policy for the future

Ranking	Product	%	Number of company
1	Productivity	67	6/9
2	Material cost	56	5/9
3	Expansion of market share	45	4/9
3	Process control	45	4/9
4	Research & Development of product	33	3/9
4	Research & Development of technology	33	3/9
4	Quality control	33	3/9
5	Labour cost	22	2/9
5	Production control	22	2/9
5	Training of working	22	2/9
5	Overhead cost	22	2/9

Such rank determine themselves the direction to which the forging industry will intend. Since the forging industry is a process industry, the enterprises must improve not only their productivity that is connected with manufacturing facilities, but also the way to spend their material cost so that the imported materials might yield more and cost low. Also the expansion of their market share is another important problem. Furthermore, product development and technical development, and quality control are important as well. They should encourage the training and education of their employees. To deal with such problems, public organ's leadership and support is indispensables to the promotion and development of the future forging industry.

Fig. 4.5.2-44 (Q73)



Q73 Main management policy to be developed (M/A) (1st to 5th priority)

1. R & D of product
2. R & D of technology
3. Productivity
4. Expansion of market share
5. Upgrading qualification
6. Diversification of products
7. Own capital
8. Labour cost
9. Material cost
10. Capital cost
11. Overhead cost
12. Production control
13. Process control
14. Design engineering
15. Cost control
16. Quality control
17. Human resources
18. Training of workers
19. Others (Specify)

3) Covernmental support and measures desired (Table 4.5.2-12 (Q74))

3)-1 Thailand's measures for promotion of metal processing industry

All measures described in Table 4.5.2-12 (Q-74) are effective for the promotion of the metal processing industry in Thailand. Government should encourage the enterprises enthusiastically.

Table 4.5.2-12 (Q74)

Q74 Preferable government assistances and assessment of esisting ones (M/A) (1st to 5th priority)

	1 Not useful	2 Useful	3 Very useful
Development of infrastructure			
1. Access road	1/8	3/8	4/8
2. Telecommunication	2/4	2/4	
3. Electric supply	1/5	2/5	2/5
4. Water supply	1/5	2/5	2/5
5. Central sewerage treating		2/3	
6. Pollution control		2/4	2/4
Technical/information services by public organization			
11. Training services		3/5	2/5
12. Consultancy services		3/5	2/5
13. Information services		3/5	2/5
14. Testing services		3/6	3/6
15. Laboratory		2/5	3/5
16. Standardization national		3/5	2/5
17. Quality control		3/5	2/5
18. Seminer/symposium		2/2	
Financial/marketing support Encouraging investment			
21. Tax rebate and tax exemption		1/6	5/6
22. Credit assistance		3/6	3/6
23. Subsidy			2/2
24. Marketing		4/7	3/7
Protection of domestic products			
31. Import surcharge		2/6	4/6
32. Import restriction		2/4	2/4
33. Export promotion		1/4	3/4

3)-2 Examples of machinery industry promotion measures in Japan

The same measures have been carried into effect since 1956 at the stage of development in Japan's industry by enacting Machinery Promotion Law, Machine and Electric Law, and Mechanical Information Law. As a result, small enterprises in the forging industry

have attempted to modernize their equipments, and to execute the improvement of productivity, and saving energy and labor, being succeeded in the betterment of operation, quality, and environments, as well as in decreasing cost. It means that the enterprises have changed their equipments such as mechanical hammer press, and coal furnace, into petroleum furnace, and promoted the use of mechanical transporters. With their employees, the enterprises have started the technical skill qualification system (by the state examination) for each industry, making their skill to be upgraded. They have set up public organs including local technology centers and job training centers where local technology have been attemted to be improved. In addition, government have tried to promote technology by setting up national technology centers or institutes for each industry which have integrated the local centers. For example: The Material Process Technology Center, Japan Society for the promotion of Machine Industry, Japan Automobile Manufacturers Association, Inc., Japan Motor Industrial Federation.

(7) Environments and others (Fig. 4.5.2-45, Table 4.5.2-13, Table 4.5.2-14 (Q-90-00, Q90, Q94))

Since most forging factories are located in the industrial are (6/9 companies), complaints about pollution are seldom mentioned. (8/9 companies) There are no plans to move their factories.

Fig. 4.5.2-45

Q-90-0 What district is your firm situated in? (S)

1. Industrial district
2. Industrial district (customs free zone/free export zone)
3. Commercial area
4. Residential area
5. Not defined

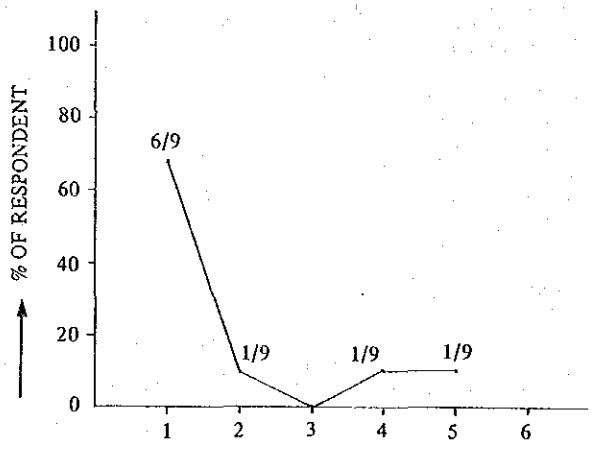


Table 4.5.2-13

Q-90-1 Have you ever got claims of industrial pollution? (S) and What kinds of claims are they? (M)

1. Yes 1/9
2. No 8/9

Table 4.5.2-14

Q-94-1 Do you have relocation program of your factory? (S)

1. Yes 0/6
2. No 6/6

(8) Current state of things and promotion of the forging industry

1) Current state of affairs of the forging industry of Thailand

a. The forging industry of Thailand consists mostly of forgings-manufacturing factories that make forgings by purchasing steel materials (bars and billets) from outside, and the so-called steel-forging industries that carry out an integrated forging process ranging from the bloom to the forging of the finished product are rather rare.

b. Most of the forging industries of Thailand have other occupations, with exception of several firms dedicated exclusively to the business.

c. The forging industries have relatively large capital, but the said fact is attributable to their dedication to other occupations besides forging.

d. The turnover is small compared with the capital.

e. The forging industries have small-scale plant and equipment which are presumed to be quite primitive.

f. As for the number of employees, it is difficult to know accurate details because the firms have other occupations, but those ones of the forging sector are presumed to be of the order of 11 to 20 persons.

g. The number of years of experience of the employees in the trade, the wages, the educational level and the training system are at a low level.

h. The products manufactured by the forging industry of Thailand are automotive parts, industrial machinery parts, ordinary industrial machinery parts, dies, of various kinds, etc. The unit weight of most of the forgings is of the order of 1 to 3 kg.

i. As for the forging method, stamping is more popular compared with free forging.

j. It is presumed that the forging equipment and machinery consist mostly of small-capacity board hammers and beche hammers, with exception of large-scale industries. Hand hammers are also used very popularly.

As for the heating furnaces, petroleum-burning box and batch-type furnaces are the most popular ones, but coke and charcoal ovens are used as well.

Most of the dies are imported, with exception of some ones constructed in Thailand.

The totality of steel used as materials is imported.

k. The monthly production scale in terms of weight is under 1000 kg/m in most of the cases. As for the production in terms of units, there are firms turning out more than 1500 pcs/M.

l. Equipment for measurement, inspection, composition analysis, etc., are very rare, and the number of personnel in charge of the said jobs is also very small.

m. Investments in research & development are very small.

n. There is insufficiency regarding the quality control system. The inspection records are rare and the percentage of defective products is high.

o. The totality of raw materials is imported, but the forging yield is low.
Oil, charcoal, coke, etc., are used as fuel in the forging industry of Thailand.

p. Practically the totality of the market is domestic.

q. Cost control and market survey are carried out in a general way, but further detailed following is needed.

r. As for the environment, most of the forging industries are located in industrial areas, complaints about pollution are rare and there are no plans for removal of factories.

2) Promotion of the forging industry

a. Expansion of the market and increase of the demand
The promotion of agressive measures by the government and public institutions is required in this connection. The increase of the demand is the most urgent issue. The domestic production should be promoted by specifying concretely the list of articles.

b. Upgrading of the production technique
It is difficult to say that the level of the production technique in general is high. This is a problem related to plant and equipment, but in reality the production is small and people seem indifferent to the quality. For example, crankshafts are normally manufactured by machining steel materials but in Thailand they are manufactured by forging round steel bars. This is not adequate because it wastes material, the quality of the finished product is not good and furthermore the percentage of defective products is high.
The following countermeasures are proposed in order to solve the said problems.
① In the first place the government and public institutions should provide appropriate guidance and aid.
② The re-education of executives, management people and workers is badly needed.

c. Increase and modernization of production facilities
The production facilities are poor and the production capacity is small. The manufacturing of forgings in conformity with the available plant and equipment should be borne in mind.
It is necessary to select appropriate plant and equipment in conformity with the forgings to be manufactured, and to consider measures to modernize them.

Serious study is required in connection with the forging machinery and heating furnaces.

Furthermore, energy-saving studies are also required in connection with the use of fuels.

d. Diffusion of control technology

① The diffusion of the quality control philosophy is insufficient. It is necessary to revise the totality of the quality control system. As things not stand it is difficult to manufacture products with stable quality.

② Process control

It is necessary to ensure countermeasures to cope with delays in the terms of delivery, and furthermore it is necessary to improve the schedule control.

③ Control of materials and fuel

In the forging industry fuel and materials are crucial factors exerting decisive influence on the cost and quality. Control systems suiting the forging methods and facilities are required in order to prevent precious imported steel materials from being wasted. The same considerations are valid also with regard to the use of materials, and careful efforts are required in connection with energy saving. It is desirable to develop methods and processes making it possible to use natural gas. Guidance and aid of the government and public institutions are required in connection with the definition and method of implementation of the basic concepts required for learning of the aforesaid control techniques. Furthermore, it is indispensable to consider the larning process of the employees in the long-range in order to obtain satisfactory results.

e. Equipment and improvement of the education and training system

Education of executives regarding basic aspects of the forging industry is badly needed, and a powerful guidance and aid of the government and public institutions is indispensable in this connection. As for the engineers, they must be submitted to extensive training ranging from basic aspects to practical applications focusing principally on control techniques and production techniques, and a powerful guidance of an authoritative government institution is required.

An example of curriculum to be implemented in the said education and training scheme is shown in the Table (training curriculum).

Supervisors and workers should be submitted to training consisting principally of practical techniques.

As for the institutions in charge of the said training programs, it is desirable to select appropriate national or regional training centers for this purpose.

Furthermore, it is desirable to create a technical skill qualification system at national level for each type of occupation in order to make the technical skill of the workers more authoritative.

Table 4.5.2-14 Example of training curriculum

Item	Class	Training item	Implemention method
1.	Engineer	Forging method Forging equipment Forging design Forging material Forging technique Quality control and inspection technique	Training in institute (long term) Training in seminar
2.	Supervisor	Forging design Forging equipment Material Forging technique Finishing technique inspection technique	Training in institute Travelling guidance and seminar
3.	Worker	Forging work Material heating work (Furnace operation) Finishing work Inspection work	Training in training center Travelling guidance and in-house training

f. Promotion of standardization

It is necessary to promote the standardization and normalization of products and materials in order to stabilize and improve the quality and the cost. Powerful guidance and aid of the government and public institutions are required in this connection. Standardization should be carried out also in connection with the work, and work standards should be defined for each process. Public institutions should provide guidance and consider measures to encourage the standardization.

g. Diffusion and examination of measuring, test and inspection equipment

Public institutions should provide powerful guidance to comple the forging industries to fit themselves with simple measuring, test and inspection equipment (e.g. hardness meter, color check equipment, thermometer, etc.). The following alternatives are proposed in connection with expensive equipment (e.g. material test equipment, chemical composition analysis equipment, non-destructive test equipment, etc.).

1 To equip them in public institutions and to allow their use by private firms.

2 To equip them in each region for collective use by the private firms.

The accuracy of the equipment should be inspected and approved periodically by the government or public institutions.

h. Supply of information of various kinds

The government or public institutions should supply domestic and overseas information about technical matters, marketing, procurement of materials, etc., to the private firms. This is an important part to be played by the government and public institutions, and a powerful and aggressive attitude is required in this connection. Powerful support of the government and public institutions is required particularly in connection with marketing, because otherwise the promotion of the forging industry will be impossible. The increase of the demand is a pressing need.

i. Encouragement of R&D activities

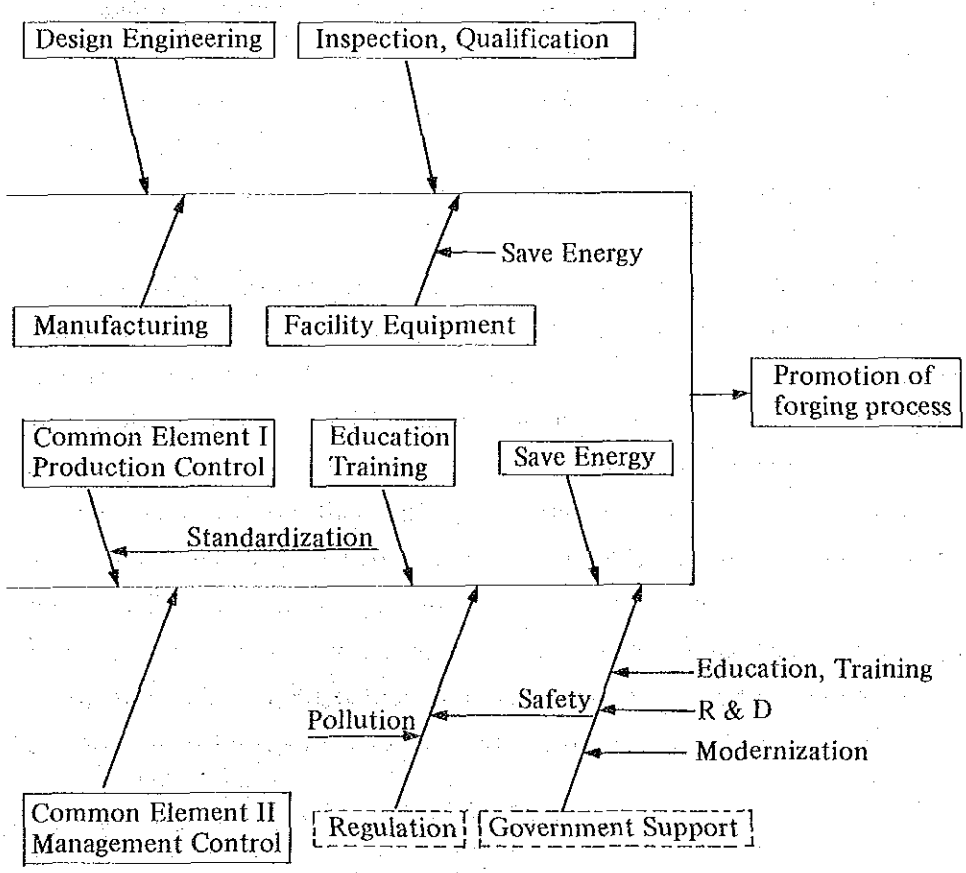
The government and public institutions should carry out powerful R&D regarding both products and processes, in order to provide guidance and aid to private firms. On the other hand, R&D activities of the private sector should be encouraged by rewarding inventions, and measures should be considered in order to attempt the expansion of the demand. A plausible alternative in this connection is the acceptance of suggestions of the private sectors by public institutions for commissioned research and test. The use of natural gas as fuel of heating furnaces for forging is an issue to be considered with priority by the government and public institutions, because it will contribute to reduce the consumption of imported fuel, making it possible to use domestic energy resources, and contributing furthermore to the control of pollution and improvement of the environment thanks to its peculiarities as clean fuel.

j. Recapitulation

Considerations about measures to promote the forging industry of Thailand were described in the foregoings. Forgings are used widely in the automotive parts industry, agricultural machinery parts, mining machinery parts, ordinary industrial machinery parts, etc., but in reality the importance of the forging industry seems to be overlooked in Thailand. Such being the case, the government and public institutions are required to consider powerful policies, measures and guidance, by referring to the example of industrialized countries, in order to promote the forging industry in Thailand, paying special attention to the expansion of the demand. The guidance policy of the government is the most important factor for the promotion of the forging industry.

The aforestated considerations are summarized in the following diagram.

Fig. 4.5.2-46 Diagram of promotion of forging process (Total system)



4.5.3 Sheetwork/welding

Out of total 334 companies of the object firms of the present investigation, 81 companies (24.3%) and relative to 235 companies of the object subcontract firms 34.5% are engaged in sheetwork/welding processes in some form or other.

Out of the above those which rely on sheetwork/welding process 50% or over of their enterprise activities are merely 4 companies (4.9%) and the actual state has been made known that almost all of them position sheetwork/welding process as one process of production line. Hereunder such actual state will be mentioned according to each principal item. As for the summary according to the cause – effect diagram of Figure 4.5.3-1 relation between questionaire code numbers (Q-No.) is shown and the problem structure and process for solution of problem points have been clarified.

(1) Scale of firms

1) Capital (Q01-1)

As shown in Table 4.5.3-1 enterprises of ฿250 x 10^3 or less account for about one half and in the case of ฿1,000 x 10^3 or less about 80% are included. Almost all enterprises belong to the scale of capital ฿1,000 x 10^3 or less.

2) Sales (Q01-2)

As shown in Table 4.5.3-1 relative to the scale of yearly amount of sales ฿4,000 x 10^3 or less account for 77.8%. Particularly, small scale business of amount of sales ฿250 x 10^3 or less account for about 36%.

3) Factory estate area (Q01-3)

Enterprises of 2500m^2 or less account for about 2/3. On the other hand, it is known that enterprises exceeding 16,000m^2 are close to 9%.

Further, an enterprise having two or more plants different in location has been recorded one in number.

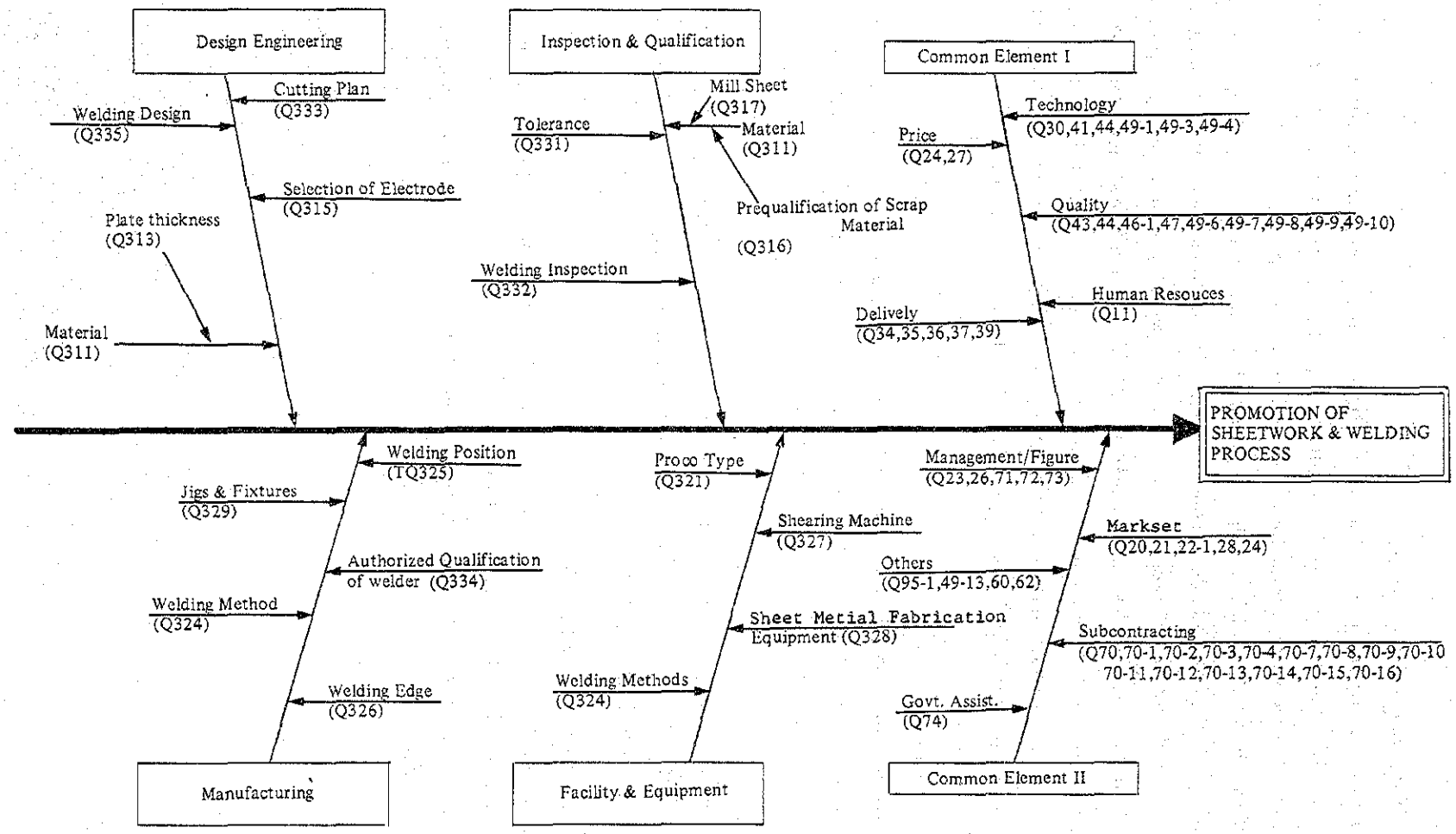


Fig. 4.5.3-1 Cause-effect diagram for promotion of sheetwork & welding industry