3.3 Selection of Promising Industries, Current Situation of Technological Level, and Improvement Measures

3.3.1 Definition and Selection Criteria of the Promising Industries

The promising industries are hereby defined as those industries which satisfy the following conditions at the same time: (a) the industries which require expansion of producion at present or in the nere future in aspect of demand and (b) the industries which are suitable for MEs and SMEs to produce.
Therefore, those industries which presently have sufficient production capacity in the country and also will not require expansion of production capacity even in the near future are eliminated from the promising industries.

To select promising industries (products) in the metal-working industry, the following criteria were established from both the short-term and medium- and long-term viewpoints:

From the short-term viewpoint, the following three criteria were established:

1) A product for which large domestic demand exists but production capacity is insufficient, or for which sufficient production capacity is available but production is not carried out due to lack of communication between manufacturers and users, thereby to depend on imports;

2) A product which can be produced by using currently available technology or improving production technology, or introducing new production equipment; or

3) A product which is locally produced under sufficient capacity, with relatively small difference in price and quality from imported products, and which exports are expected to increase by improving design.

On the other hand, the selection criteria from the medium- and long-term viewpoint focus on industries and products for which domestic markets are expected to grow with industrialization of Colombia for a time span of 5 to 10 years and which can offer comparative advantage through planned improvement of technological capability.

The selection criteria based on the medium- and long-term viewpoint were established as follows:

1) A industry to manufacture capital goods or intermediate goods which serve as a basis of industrialization;

2) An industry which supports the development of other sector(s) (including production of raw materials); or

3) An industry which development is not technologically or economically feasible in the short run but capable of expanding markets by using comparative advantage of the country and implementing appropriate policy.

The above selection criteria were developed on the basis of corporate visits conducted in the field survey, interview with related authorities and organizations, relevant plans by public organizations and private enterprises, statistics of exports and imports, statistics of domestic production, and other relevant data and information available in Colombia, as well as with reference to industrial development process and experience in newly industrializing countries in Asia and ASEAN countries.

As for products, selection was limited to the metalworking industry. In addition, related products which are used as metalwork products were considered in the process.

3.3.2 Selection Process and Results

Each sub-sector of the metalworking industry was evaluated in accordance with the selection criteria described in 3.3.1. (See Table 3.96)

(1) The selection criteria were conceptualized to four major criteria of "Domestic market", "Export increase", "Technological level", and "Contribution to metalworking and other industrial areas", each of which was sub-classified as follows:

(A) Domestic market

a) A product for which domestic market is small at present and can not be expected to grow significantly in the future. (Negative factor);

b) A product for which domestic market is small at present but can be expected in the future so as to require the increase in the number of manufactures;

c) A product in which the sufficient number of manufacturers operate to satisfy domestic demand, including the future demand. (Negative factor); or

d) A product for which demand is big at present and potential supply capacity to satisfy the demand exists, requiring the increase in supply capacity in the future.

(B) Export increase

a) A product whici is exported in minimal quantities at present and has less possibility of export increase (Negative factor);

b) A product which is exported in minimal quantities at present but has high possibility through improvement of competitiveness in quality and price;

c) A product which is exported in significant quantities but is not expected to increase exports in the future (Negative factor); or

d) A product which is exported in significant quantities and is expected to increase export in the future too.

(C) Technological level

a) A product which can be manufactured by slightly improving currently available technology in Colombia or introducing some equipment; or

b) A product which cannot be manufactured by currently available technology in Colombia but is highly needed to develop domestic production in the future as a country's development policy; or

c) A product which is desirable to continue dependence upon imports because of necessity of highly sophisticated technology (Negative factor).

(D) Contribution

a) A product which highly contributes to the metalworking industry;

b) A product which highly contributes to other industrial areas; or

c) A product which highly contributes to improvement of living standard.

All products subjected to this Study have been classified one by one into the above sub-classified elements of each criterion. The results are shown in Table 3.96.

As the first step of the selection procedure, each product was examined by the criterion of "(C) Technological level". A product which falls in the negative factor, namely (C)-c), was removed from the promising

products, being market by "X" in the table, even if it satisfies other conditions.

Second, each products was examined by the criterion of "(A) Domestic market". A product which falls in the negative factors, namely (A)-a) or (A)-c), is not prospective in aspect of domestic market, being marked by "X" in the table. However, those products which were marked by "X" are not necessarily removed from the promising products because some products might be prospective in the export market.

Finally, each product was examined by the criterion of "(B) Export increase". A product which falls in the negative factors, namely (B)-a) or (B)-c), is not prospective in aspect of the export market. Possibility of the export increase was judged mainly using a measure whether the domestically produced product has competitiveness in international market in quality and price. And then, a product for which negative factors were put in both criteria, "(A) Domestic market" and "(B) Export increase" at the same time, was removed from the promising industry.

Besides, since the criterion of "(D) Contribution" does not have any negative factors in its sub-classified elements, there is no product which was removed from the promising product under this criterion. Products remained after above filtration in terms of technology level and marketability were identified as the promising products.

As a result, 11 industries were selected as the promising industries in the short-term, and 7 as the promising industries in the medium- and long-term. It should be noted that the promising industries are considered to include "processes" to manufacture products, in addition to their products, because the processes such as forging, casting, thermal treatment, plating and welding are expected to develop side by side with the improvement of product quality and productivity. Clearly, such interdependence between

products and processes should be properly addressed in selection and promotion of the promising industries.

The last column of Table 3.96 shows suitable production capacity for each product. Here, symbols "L", "M", "S" and "ME" stand for large-, medium-, small-, and micro-scale.

Promising industries on the short-term basis

1) Repairing of agricultural machinery and construction equipment, and production of spare parts
2) Repairing and modification of machine tools
3) Production of small automotive parts for servicing
4) Production of assembly and repair parts of motorcycles
5) Electrical household appliances
6) Small and general molds (for plastic and press)
7) Electric motors, in particular 3-phase and 40HP or larger output models
8) General-purpose pumps and valves
9) Plastic molding machines
10) Furniture
11) Interchangeable components

Promising industries on the medium- and long-term basis

1) Hand tractors
2) Small- and medium-sized lathes, milling machines, and radial drilling machines
3) Major automotive parts for assembly
4) Large and high precision molds
5) Medium- and large-sized pumps and valves, and high- and medium-pressure pumps and valves
6) Diesel engines
7) Hydraulic equipment components

(2) In addition, to take into account local conditions of Colombia, each product studied in "3.1 Metalworking and Related Industries" and "3.2 Current Situation of Sub-Sectors" was evaluated on the basis of the selection criteria. Then, results of the questionnaire survey in "4.1 Analysis of Results of Questionnaire Survey and Corporate Diagnosis" and "4.2 Technical Problems Related to Metalworking Process" were evaluated to understand SMEs and MEs in the metalworking business from technological and management aspects. These evaluations were summarized in Tables 3.97, 3.98, and 3.99. On the basis of related data, analysis was made for each of sub-sectors and products as follows.

1) Agricultural machinery and construction equipment

At present, tractors, combines and harvesting machines are all imported largely because only a small number of large farms can afford these costly machines to limit market sizes, as discussed in 3.2. As a result, there is a limited number of agricultural machinery available in Colombia.

For instance, in 1987, there were approximately 24,000 tractors owned throughout the country, or 5.07 units per 1,000ha of cultivated area. This is one third the world average of 16.60 units and is ranked the third from the lowest level in Latin American countries (see the table below). If the mechanization rate is to be raised to a level in Brazil (10.16 units/1,000ha), additional 24,000 tractors are needed, and to the world average level, the current ownership needs to be increased to 72,000 units.

Number of Tractors per 1,000 Hectare of Cultivated Area

Country	1974-1976	1981	1983	1985
Argentina	5.19	4.51	5.65	5.66
Brazil	4.41	4.64	9.50	10.16
Chile	6.52	6.27	6.22	6.21
Colombia	4.55	5.04	5.04	5.07
Ecuador	1.97	2.69	2.98	3.07
Peru	3.82	4.44	4.92	4.95
Uruguay	20.69	23.10	23.16	23.18
Venezuela	7.75	10.39	11.04	11.54
Mexico	4.25	6.10	6.45	6.34
United States	27.21	24.42	24.60	24.62
Japan	137.67	291.14	329.65	389.58
France	71.98	81.85	81.85	80.62
West Germany	188.83	195.81	197.57	199.25
East Germany	28.29	29.39	30.68	31.78
United Kingdom	68.93	73.66	75.79	74.26
World average	13.08	15.06	15.77	16.60

Source: "Evolucion y Costos de la Mecanizacion Agricola em Colombia" Sociedad Agricultores de Colombia-1988

The report estimated the average age of tractors operated in Colombia at around 10 years, of which 44% were operated for 10 - 17 years, 40% for 5 to 10 years, 16% for 5 years or less. Assuming that each tractor becomes out of service after 15 years of use, and if the mechanization rate is to be raised to the world level in 1985 within 5 years, 11,000 units need to be purchased each year. Such potential demand, including other agricultural machinery, can be realized if agricultural cooperatives are formed to facilitate the communal purchasing or leasing by small farms, together with increase in farm income.

At the same time, there is sizable demand for repairing of agricultural machinery in operation; including 24,000 tractors, 40% of which are 10 years or older. As there is little data available to estimate the demand, general requirements for repairing and replacement of agricultural machinery may be described on the basis of experience in Japan.

In Japan, service life of tractors and other agricultural machinery is considered to be 10 years, during which some repair and replacement carried out periodically, depending upon operating environment (rice and other fields, and graze). In particular, parts related to the lubricating system such as filters and oil seals are replaced annually. Also, replacement of moving parts such as piston rings, and repairing and replacement of implement fittings are occasionally carried out.

This example suggests that, as nearly a half of tractors used in Colombia is 10 years or older, a large number of agricultural machinery requires repair and replacement of various parts and components, ranging from accessories, driving shafts and gears, to piston cylinders, in addition to expendable supplies.

The situation is similar in construction equipment, most of which is imported. At present, around 20,000 units are operated throughout the country. Demand for construction equipment is primarily dependent upon public works and construction projects in the private sector, and it grows at 2% to 3% annually. In addition, the demand related to arable land development and coal mining is expected to grow 3 to 4 times the present level in the next few years, according to a major importing firm. Nevertheless, this is not sufficient size to support domestic assembly operations.

On the other hand, considerable demand for repair parts is expected due to harsh operating environment.

In Japan, for instance, construction equipment is operated for around 10 years, while service life on the tax law is 5 years and standard service life set by the Ministry of Construction is 7 years. Parts and components subject to wear, such as those related to fuel supply and lubricating systems (hydraulic pumps, cylinders, filters, pipes, hoses, and caps) and shovel rippers, as well as caterpillars, shafts and gears, and rollers, are repaired and replaced frequently.

In Colombia, on the basis of existing ownership and annual import record, it is estimated that more than a half of construction equipment has been used for 10 to 30 years, to suggest that many of them require major repair.

It should be noted that agricultural machinery and construction equipment use many parts and components based on common technical standards, which can be manufactured at a same plant. At the same time, there are automobile assembly plants, as well as suppliers of assembly and repair parts and repair shops. This suggests that domestic production of repair and replacement parts for agricultural machinery and construction equipment is highly practicable if appropriate technical support and equipment investment are made.

The above analysis indicates that the repairing of agricultural machinery and construction as well as production of spare parts satisfy items 1) and 2) of selection criteria from the short-term viewpoint.

On the other hand, hand tractors are considered to satisfy items 1), 2), and 3) of the selection criteria based on the medium- and long-term standpoint. Hand tractors, less costly than larger tractors, are

affordable for small farms, thus are expected to generate large demand. On macro economic perspective, they will contribute to development of agriculture and construction sectors. Production is possible by applying present technical levels learned through repairing and parts production.

2) Machine tools

Machine tools are a foundation of the metalworking industry and their demand increases with development of metalworking and machinery industries. In particular, small- and medium-sized lathes, drilling machines, and milling machines are highly useful for SMEs and MEs because of their versatility, and the government is expected to promote development of the industry segment.

At present, Colombia does not have a sufficient production capacity of machines tools. For instance, there are 3 companies registered as lathe manufacturers, but no production is carried out. On the other hand, results of the corporate survey indicate that SMEs and MEs visited by the Study Team own machine tools which are mostly deteriorated due to aging, with poor productivity and accuracy.

As statistical data was not available in the country, the number of machine tools owned was estimated from the results of the corporate survey. An conservative estimate ranged between 6,000 and 8,000 units in Bogota, Medellin and Cali (including Palmira). If 5% to 10% of these machines are to be repaired or upgraded (for improvement of accuracy in particular) each year, the market size would be between 300 and 800 units annually.

The repairing of machine tools requires highly precise mother machines, and advanced skills and experience. To promote this business, therefore, requires technical support from foreign experts or SENA at the initial stage. Once sufficient techni-

cal levels are attained, production of small- and medium-sized lathes, upright and radial drilling machines, and milling machines becomes feasible in the long run, provided that related production technologies including casting and forging are to be developed at the same time.

The repairing and upgrading of machine tools can be considered as the promising industry to satisfy requirements 1) and 2) of the selection criteria from the short-term perspective. Note that the repairing means general maintenance and repair works, while the upgrading includes modification of obsolete machines to improve their performance (accuracy in particular) or for automation.

On the other hand, production of small and medium lathes, milling machines and radial drilling machines, is considered to be promising on the medium- and long-term basis. It satisfies requirements 1) and 3).

Finally, as for bending machines, hydraulic presses, and shearing machines which are locally manufactured, the domestic supply capability meets the demand for the time being by improving productivity of existing makers.

3) Transportation equipment

This sub-sector include automobiles, motorcycles, bicycles, and elevators.

First of all, automobiles are assembled by three registered companies, which produce around 60,000 units annually against the total production capacity of 84,000 units. Judging from the domestic market size and purchasing power, the present capacity can meet the demand in the long run.

The automobile industry has a linkage to a wide range of industries and plays an important role in

generating employment opportunities. In Colombia, there are 120 to 130 suppliers to provide parts and components for the assembly makers. Tires and wheels account for some 28% of all parts and components produced by the suppliers, other assembly parts 26%, and spare parts for after-sales markets take care of the rest. At present, the suppliers manufacture only small parts and components and do not satisfy requirements by the assembly makers in terms of quality and price. Large parts and major components requiring advanced production technology and equipment are imported in the form of finished or semi-finished products. This partly explains that the automobile industry in Colombia records relatively the low value added.

In terms of technical capability, the suppliers will be able to provide small parts and components meeting required quality and price levels by technical assistance and management advice. Presswork, welding, plating, and painting appear to need technical improvement, and intermediate materials such as cast and forged products require quality improvement.

In contrast, domestic production of engines, transmission and other major equipment, and body parts entails major investments in equipment, technology, quality control, and production management, and technological development in material industries, e.g., casting, forging, presswork, and mold manufacturing, becomes prerequisite. It should be pointed out that there are large forging shops and factories producing gears by high precision machine tools, which are not fully utilized.

Based on this understanding, production of high-grade small parts and components for automobiles appears to be suitable for fostered development on the short-term perspective. On the other hand, to develop industries which manufacture major components and intermediate materials, enterprises capable of producing automotive parts, including the

forging shops and gear manufacturing shops, need to be effectively linked to the automobile industry.

Parts for after-sales markets can be exported through quality improvement and price reduction.

On the medium- and long-term basis, domestic production of major parts and components for new automobiles is considered to be promising as a source of import substitution. Table 3.58 lists the parts selected for this purpose.

As for motorcycles, 4 joint ventures with foreign makers are authorized as assembly enterprises. Motorcycle demand is 20,000 to 30,000 units annually, and some 300,000 units are owned. Compared to automobiles, the market and ownership of motorcycles are one third or one fourth in size.

Relatively the slack market is partly attributable to restrictions on sales - 125cc or larger models are marketed by companies only - and production of 200cc or larger models. As a result, the capacity utilization rate of the assembly makers remains at 40% levels. Most of parts are imported, and the nationalization rate is 5% to 10% on a price basis.

Given the above restrictions and relatively high prices compared to average income of Colombian people, the demand for motorcycles is not likely to grow significantly in the foreseeable future. On the other hand, it is technically feasible to raise the nationalization rate to 40% to 50% which have been achieved for parts and components for small cars. For this reason, production of assembly and spare parts was selected as a promising sub-sector from the short-term standpoint.

As for bicycles and elevators, existing production capacities meet the domestic demand, with limited imports and relatively high nationalization rates. Thus, these industries were not selected.

4) Audio products and electrical household appliances

These products are highly popular among people and the demand grows with increase in standard of living. The present study examined television sets, radios, tape recorders, stereos, and video tape recorders (classified as audio products) and refrigerators, washing machines, air conditioners, and cooking ranges (electrical household appliances). Among them, video tape recorders are not manufactured. Also, radios and tape recorders are not produced, although two companies are registered. In electrical household appliances, microwave ovens are manufactured.

In terms of relationship to the metalworking industry, audio products do not use much metal parts and components, but mainly plastic products. Thus, the manufacture of molds for plastics is closely associated with the industry. On the other hand, metalwork parts (e.g., presswork, welding, plating) are used as much as plastic ones in electrical household appliances. There are several enterprises each to manufacture audio products and electrical household appliances, which production capacity meets the domestic demand. Some products are exported. The nationalization rate is much higher than other products.

These products are expected to increase in terms of domestic demand and exports through design and quality improvements and/or price reduction. Note that the capital goods program places the "rank A" priority on other products in the same sub-sector, namely telephones, telephone exchanges, electronic parts and components, computers, and controlling and measuring instruments, which were not subject to the present study. Although production data is not known, these products use mainly plastic parts and components.

Based on the above analysis, electrical household appliances are selected as the promising industry from the short-term standpoint, in terms of potential for export increase through modernization including design and quality improvement, and cost reduction. Also, production of molds for plastics and presswork is the promising industry to support electrical household appliances. Relatively small molds with low precision requirement are considered to satisfy items 2) and 3) of the selection criteria in the short run, while large molds or molds requiring precision technology meet requirements 1) and 2) of the selection criteria on the medium- and long-term perspective.

5) Electrical machinery

Electrical machinery under this study includes industrial motors, transformers, generators, panels, and kWh meters including household models.

There are 6 manufacturers of electric motors which supply 160,000 units annually, and the nationalization rate for parts and components is 80%. At the same time, the similar quantity is imported. The import rate is high for three-phase motors of 40Hp or larger and DC motors. Demand for electric motors, in particular three-phase motors of 40Hp or larger, is expected to increase with industrial development.

On the other hand, around 75% of transformers are purchased for public projects, so that the annual demand is primarily determined by the government budget. At present 4 domestic makers supply some 40% of the total market, and imports represent a majority of share. The nationalization rate for parts and components is around 60%.

As for kWh meters, 4 makers produce around 150,000 units annually, which account for only a half of domestic demand.

Finally panels are produced by 17 makers, but the nationalization rate for parts and components is relatively low at a 50% level. Only panel bodies are manufactured locally and most of components are imported.

Transformers, kWh meters and panels are highly dependent upon imports and are prospective areas of import substitution. In the process, it is desirable to increase domestic production by boosting existing capacities, rather than increasing the number of makers, which would result in overcompetition. And the increase in production capacities involves improvement of productivity and technology, in addition to increase in production equipment and manpower.

Based on the above consideration, electric motors - particularly three-phase motors of 40Hp or larger - are considered to be the promising industry from the short-term standpoint.

On the other hand, the capital goods program places high priorities on industrial furnaces, switches, and power plants. These areas were not covered by the study and no evaluation was made.

6) Industrial machinery

Industrial machinery under the study includes boilers, pumps, diesel engines, and gasoline engines, compressors, blowers, and hydraulic equipment. Among them, boilers are manufactured by using technology introduced from foreign countries and have competitiveness in export markets.

As for pumps, some 10 makers produce 15,000 to 30,000 units annually, mainly centrifugal pumps. The nationalization rate for parts and components is 90%, and some of them are exported. On the other hand, 120 gear pumps are manufactured annually to

satisfy only 10% of domestic demand.

Pumps are used for construction and farming, in addition to manufacturing operations, so that the market is expected to grow through proper sales promotion.

The capital goods program places high priorities on pumps, compressors, valves and other products in the machinery sector. For instance, it forecasts domestic demand for valves in 1991 according to types and sizes, as follows:

Bronze valves for gas supply:	
1/2" - 3/4", 150psi	800,000 units/year
1/2" - 3/4", 250psi	2,000,000 units/year
Safety valves for boilers:	
3/4" - 3"	200,000 units/year
Gate valves:	
1/2" - 3"	1,500,000 units/year
2" - 6"	100,000 units/year
Valves for water supply (including household uses):	2,500,000 units/year

On the other hand, compressors and blowers are produced by many makers, and the existing capacity appears to be sufficient for the domestic demand in the short run. Instead, improvements of quality and productivity are becoming important. In the medium- and long-run, development of larger products is desirable to meet increasing demand. In this connection, quality and productivity improvements for intermediate materials, including cast and forged products, should be given of high priority.

There is only one gasoline engine maker. Gasoline engines are manufactured by a foreign-affiliated automobile assembly maker to be installed on their products. Other two assembly makers are importing all gasoline engines required. Most of gasoline engine, demand is limited to automobile uses.

Whether two assembly makers should start local production of gasoline engines is out of the scope of this study.

Similarly, diesel engines are produced by one maker. Annual production was 300 units in 1987 and is expected to reach 2,000 units in the near future. Additional demand is expected from local production of construction equipment, agricultural machinery, and generators.

Hydraulic equipment is all imported, and domestic production is not feasible in the short run because of relatively a small market size. However, the demand is expected to grow in the long run, if local production of construction equipment, agricultural machinery, machine tools, and plastic molding machines progresses.

As mentioned earlier, the plastic molding industry is expected to grow rapidly, with increasing demand for larger and more precise products. This will increase demand for injection molding machines and extruder. The repairing and remodeling of foreign-made molding machines are already carried out. These machines can be produced by relatively low levels of technology, compared to other machine tools.

In this sub-sector, therefore, general pumps, valves, and plastic molding machines are considered as the promising industries in the short run. At the same time, medium- and large-sized pumps and valves, high- and medium-pressure pumps and valves, diesel engines, and hydraulic equipment components are considered to be feasible in the medium- and long term.

7) Furniture

There are many steel and wooden furniture manufacturers, with the high nationalization rate for parts

and components. Some of products are exported. The present production capacity appears to be sufficient for domestic demand. In the short run, efforts should be made to improve production and surface treatment techniques, with emphasis on design improvement and ornamentation. On the other hand, handicraft furniture appears to be promising for SMEs and MEs, in addition to mechanization. If these improvements are made, significant growth of domestic and export demands will be highly possible.

8) Machine elements, jig and tools

To manufacture above products locally and to increase the nationalization rate and the value added for the metalworking industry in Colombia, it is important to manufacture machine elements, jig and tools for the products locally. If not, local production of machinery will increase imports of parts and components, which do not lead to saving in foreign currency reserves.

Machine elements include bolts and nuts, rolling bearings, plain bearings, oil seals, O-rings, flange joints, pipe joints, shafts and pins, gears, shaft joints, sprocket wheels, chains, and V-belts. Hand tools, cutting tools, and jig include spanners, hammers, punches, hacksaw, cutting tools, drills, milling cutters, grindstone, vices, and lathes.

Selection of machine elements, jig and tools suitable for local production has to wait for a detailed study on market size, production technology and cost. It is pointed out that machine elements such as rolling bearings, oil seals, O-rings, shaft joints, chains and V-belts, and tools including spanners, hammers, drills, milling cutters, and grindstone are mass produced for international markets, thus more economical and feasible to import from major producing countries, including newly industrializing countries.

On the other hand, shafts, pins, gears, pipe joints, sprocket wheels, V-belt wheels, cutting tool shank, spacers and setting jig are suitable for local production, partly because they are used in many types of machinery and production processes, and partly because they are manufactured in relatively small quantities and large varieties. Also, it is desirable to produce them by SMEs specialized in production of certain products. As these machine elements can be produced through minor improvement of production equipment and technology, they are considered to be the promising products from the short-term viewpoint.

The process of selecting promising industries on the short- and long-term perspectives, together with industries selected, is summarized in Table 3.99. Improvement requirements for these industries are examined in 3.3.3.

Based on these consideration, it is important to measure and estimate the prospect and need for local production by a detailed feasibility study on each product.

3.3.3 Technical Levels of Promising Industries and Improvement Requirements

Industries selected in the previous section are those which seem to be suitable for local production in the short run or in the medium- and long-term. The former generally includes industries which require minor improvements of production equipment and technology, while the latter includes those which entail significant technological improvement and equipment investment.

This section analyzes and determines present levels of metalworking technologies according to major process.

Naturally, there is a certain degree of difference in technical level according to enterprise sizes and individu-

al enterprises. Here, technical levels of SMEs and MEs were analyzed from the results of the present study. (see 3.2, 4.1, and 4.2)

Present technical levels of production processes in Colombia are evaluated and classified into three stages: "the early stage", "the intermediate stage", and "the advanced stage". This evaluation standard is based on that used in JICA's report "Comparative Analysis of Medium- and Small-Scale Industries in Asian Countries" (compiled by the International Cooperation Research Center in March 1984)

(1) Casting, forging and heat treatment technologies

Judging from the results of the questionnaire survey and corporate diagnosis described in 4.1 and 4.2, present casting technology of SMEs in Colombia is considered to be at the lower intermediate stage or the upper early stage. MEs are evaluated as the lower to medium early stage.

To produce cast products for agricultural machinery, construction equipment, machine tools, transportation equipment, diesel engines, medium- and large-sized pumps, and valves, which appear to be suitable for local production, enterprises are required to possess technical levels at the upper intermediate to the advanced stage. In particular, production of high-grade cast iron and steel products - used for beds and columns of machine tools, gear boxes of agricultural machinery and construction equipment, casings of diesel engines, medium- and large-sized pumps, and high pressure valves - requires a wide range of advanced production technology, including quality control on raw materials, pattern making and molding, management of casting sand, management of constituents in melting, temperature control, and product inspection and testing. To conduct these activities in a systematic manner, each enterprise needs to establish production management and quality control systems and to provide proper training and education for employees.

On the other hand, forging is mainly carried out by Sml-Es and MEs. There is one large forging shop which is not fully utilized. To produce forged products capable of withstanding harsh operating conditions with increase in capacity utilization rate and productivity, high-quality raw materials, advanced production technology and equipment, and inspection and testing equipment are required. Also, heat treatment after casting or forging is another important process.

Shafts, pins, gears, cams, press molds, and other important machine elements must use high-grade forged steel. On the other hand, small- and medium-scale forging shops in Colombia are considered to be at the early stage, requiring significant technological improvement to manufacture products recommended here.

(2) Machining, special processing and measuring technologies

Machining involves the largest number of processes in the metalworking industry. Most of SMEs are evaluated as the intermediate stage, while some of Med-Es is at the lower advanced stage. MEs and some of Sml-Es are at the lower intermediate to the early stage, and in particular, they are lagged behind in use of measuring instruments, dimensional control, use of spacers and other jigs, maintenance of machinery, and tool management.

To produce small- and medium-sized machine tools, diesel engines, precision molds, and major automotive parts, which were selected as the promising industries on the medium- and long-term perspective, high precision machine tools, techniques and skills to operate them, use of adequate jig, and measuring technology to properly check products are required. Furthermore, production of precision molds and specially-shaped machine parts needs electricspark and wire cut electricspark machines and technologies in consideration of workability, efficiency and accuracy.

(3) Platework, presswork, welding, and plating technologies

In these areas, Med-Es are considered to be at the medium early to the intermediate stage, while Sml-Es and MEs are at the early stage.

These processes are critical for production of electrical household appliances, steel furniture and office equipment, which can be exported if product design and quality in terms of workmanship in the processes are improved.

For welding of thick plates and special steel, some of large enterprises which manufacture boilers and pressure vessels have high technical capabilities, including the employment of welders holding the AWS certificate and the use of non-destructive testing methods. On the other hand, SMEs and MEs have relatively low technical levels. This technology is critical not only for fabrication of building structure, shipbuilding, and erection of bridges, but for production and repairing of agricultural machinery, construction equipment, machine tools, transportation equipment, and plastic molding machines.

Presswork depends upon precision of molds and its maintenance.

Plating operations are divided into those intended for rust-proofing and external appearance, e.g., office equipment, and those intended for increasing mechanical strength, such as hard chrome plating. Although proper treatment of effluent is important for the plating industry, relatively small plating shops in Colombia carry out little treatment.

Painting is one of most important surface treatment processes. It increases product values by adding better external appearance and extends service life by preventing rust development. Thus, the improvement of painting according to product uses is as important as other processes.

Table 3.96 SELECTION OF PROMISING PRODUCTS

		Domestic Market (A)				Export Increase (B)				Technological Level (C)			Contribution to : (D)			Results of Selection		
		a)	b)	c)	d)	a)	b)	c)	d)	a)	b)	c)	a)	b)	c)			
	Present	×	×	○	○	×	×	○	○	○	×	×	Metal/work industry	Other sector	Improvement life	Promising in short term	Promising in medium and long term	Appropriate size of production scale
	Future	×	○	×	○	×	○	×	○	○	○	×						
Negative Factor as Promising Product		×		×		×		×				×						
Agricultural Machinery	Components & Repair		○			×				○				○		○		M, S, ME
	Tractor		○				○				○			○			○	M, S
	Combine/Thresher Harvester	×				×					○			○				M
	Coffee pulper			×				×		○				○				M
	Sowing machine			×		×				○				○				M
	Implements			×				×		○				○				S, ME
Construction Machinery	Components & Repair		○			×				○				○		○		S, ME
	Assembly	×				×					○			○				M
Machining Tools	Repair		○				○			○			○			○		S, ME
	Lathe		○				○				○		○				○	M, S
	Drilling machine		○				○			○			○				○	M, S
	Milling machine		○				○				○		○				○	M, S
	Grinder	×				×						×	○					M, S
	Shearing machine			×		×				○			○					M, S
	Bender	×				×				○			○					M, S
	Press			×		×				○			○					M, S
Transportation Equipment	Automobile ass'y			×		×					○							L, M
	Autobicycle components				○		○				○			○		○	○	M, S
	Autobicycle ass'y			×		×				○								L, M
	Autobicycle components		○				○			○	○			○		○	○	M, S
	Bicycle			×		×				○								L, M
	Elevators			×		×				○				○				M
Audio-Visual Equipment	Television			×		×				○					○			L
	Radio and Tape recorder	×				×					○				○			L, M
	Stereo			×		×				○					○			L, M
	Video recorder		○			×						×			○			L, M
Home Electric Appliance	Refrigelator				○		○			○					○	○		L, M
	Washing machines				○		○			○					○	○		L, M
	Air-conditioner				○		○			○					○	○		L, M
	Cooking range				○		○			○					○	○		L, M
Electric Machinery	Electric motor				○		○			○			○	○		○		L, M
	Transformer			×		×				○				○				M
	Generator	×				×					○			○				M, S
	Panel			×		×				○				○				M, S, ME
	kWh meter			×		×				○				○				M, S, ME
	Switch, Relay			×		×				○				○				M, S, ME
Industrial Machinery	Boiler	×				×					○			○				L, M
	Pump & Valve		○				○			○	○			○		○	○	M, S
	Diesel engine		○				○				○			○			○	L, M
	Gasoline engine		○			×						×		○				L
	Compressor			×		×				○				○				L, M
	Blower			×		×				○				○				L, M
	Hydraulic component		○			×					○		○	○			○	M, S, ME
	Plastic injection machine		○				○			○				○		○		M, S
Metal furniture					○				○							○		M, S, ME
Basic Components & Tools and Jigs	Bearing, Oil seal, O-ring				○	×						×	○	○				L, M
	Shaft, Pin, Gear, Spline				○	×				○			○	○		○		S, ME
	Hand tool, Cutting tool				○	×						×	○	○				L, M
	Mould, Die		○			×				○	○		○	○		○	○	S, ME
	Chain, Belt		○			×						×		○				L, M
	Sprocket wheel, V-belt wheel		○			×				○				○		○		M, S

Note: ○ : possible, increasing or effective
× : impossible, not increasing remarkably or not effective

Table 3.97 CURRENT SITUATION BY SUB-SECTOR

	Demand unit/year	Existing unit	Domestic Production unit/year	Import & Export unit/year	Technological and Other Aspects
Agricultural Machinery					
Tractor	1,000 (potential demand: 11,000)	28,000	None	Imp. 1,000	Better than average firms Operational ratio 60% Large potential demand but small market
Combine	40-50	1,000	None	Imp. 40-50	Shaped steel, spring, oil pump, gear and universal joint are imported.
Harvester	n.a	n.a	None	Imp. US$ 11mill.	
Thresher	n.a	n.a	7units US$30mill.	Exp. US$1.5mill.	
Coffee pulper	n.a	n.a	12,380	Non	
Sowing machine	n.a	n.a	80% of demand	Imp. US$1.5mill. Exp. US$0.12mill.	
Implement	n.a	n.a	More than 20firms		
Construction Equipment	800 Potential demand: 2,500-3,200	20,000	Non	Imp. 100%	Demand depends on public works Increasing in leasing business 90% of spare parts imported through unofficial routes. Possible in CKD
Machine Tools					
Lathe	30	n.a	--	Imp. US$13mill.	3 firms registered, but no products
Drilling machine	n.a	n.a	2,000	Imp. US$1.6mill.	3 of 8 registered firms produce
Shearing machine	50-000	n.a	250	Imp. US$0.38mill.	4 firms registered
Milling machine			repaire; 20	Imp. US$7.66mill.	2 firms registered
Grinding machine	n.a	n.a	None	Imp. US$4.8mill.	No firm registered
Bender	n.a	n.a	40	Imp. US$1.8Mill. Exp. US$0.076mill.	One firm registered
Hydraulic press	n.a	n.a	10-50	Imp. US$112mill.	3 firms registered
Mechanical press	n.a	n.a	2-3	Imp. US$0.314mill.	
Transportation Equipment					
Automobile	n.a	1,370,000	61,000	Imp. 12,000	3 ass'y firms, 155 components firms Nationalization 90%. Operating ratio 73% at ass'y shop, components 50%, V.A. 10%
Motorcycle	2-30,000	300,000	2-30,000	Imp. US$0.002mill. Exp. US$0.10mill.	4 ass'y firms, 10-15% demand expansion expected Part nationalization 5-10%
Bicycle	n.a	n.a	4,100	Imp. US$0.56mill	Nationalization 70%
Elevator	n.a	n.a	220	Imp. US$7.96mill.	6 firms, Nationalization 60%
Electric Appliance					
TV	n.a	n.a	100,000	Imp. US$14.7mill. Exp. US$0.122mill.	14 firms: Almost all components imported, Nationalization 30-50%
Radio, Tape recorder	n.a	n.a	100	Imp. US$74,100	2 firms
Stereo	n.a	n.a	30,000	Imp. US$8.47mill.	12 firms: Smuggled components dominant
Video	n.a	n.a	None	Imp. US$3.74mill.	none
Refrigerator	Potential demand (300,000)		205,000	Imp. 1% Exp. US$0.28mill.	5 firms Nationalization 70-95%
Washing Machine	(100,000)		50,000	Imp. 1% Exp-inactivate	5 firms, 35-80%: Not available for sub-contracting system
Air conditioner	(15,000)		10,000	Imp. US$1.6mill.	10 firms, 60%
Cooking range	(100,000)		Elec 93,000 Gas 50,000	Exp. US$0.46mill. Exp. US$1.5mill.	5 firms, 95%
Erectric Machinery					
Motor	n.a	n.a	160,000	Imp. same as domestic prod.	6 firms Nationalization 80%
Transformer	n.a	n.a	US$25mill.	Imp. US$15mill.	4 firms, nat' 60%, 75% for government
Generator	n.a	n.a	800	n.a	n.a
Panel	n.a	n.a	US$6.7mill.	Imp. US$8.5mill.	17 firms, 50%: Cabinet body domestic most components imported
kWh meter	Potential demand (350,000)		150,000	n.a	4 firms, 30% began production 3 years ago
Switch & relay	n.a		n.a		10 firms, 30-40%
Furniture					
Steel furniture	n.a		650,000PCS	Imp. US$0.33mill.	26 firms, 95% nationalized.
Wooden furniture	n.a		550,000PCS	Imp. US$0.20mill. Exp. US$3.6mill.	200 firms, 95%: Design and painting are main points
Industrial Machinery					
Boiler	n.a	n.a	130-150	Imp. 0.16mill. Exp. 6.30mill.	5 firms, 85% nationalized, technical coop. with oversea firms
Centrifugal pump	n.a	n.a	15,000 ~30,000	Imp. 3mill. Exp. 1.5mill	10 firms: 90% nat'l, technical introduction copied products
Gear pump	n.a	n.a	120	1,000	
Diesel engine	n.a	n.a	300	Imp. US$3.5mill.	Under 35 HP. 30-50 sub-contractors, one firm, expected demand '89:1800, '90:1400, '91:1440
Gasoline engine	n.a				One firm
Compressor			18,900	Imp. 62%	16 firms 2-size 90% imported, nationalized 90%
Industrial blower			1,270	Imp. US$0.95mill	Major firms cooperated with oversea firms 5 firms
Hydraulic equip.			None	Imp. US$0.67mill	One of them tech. coop. with foreign firms 2agents with engineering, some vane pumps started production by KD.

Table 3.98 CURRENT SITUATION BY PROCESS

	Production	Main Demand for	Import	Export	Technological and Other Aspects
Casting	'85: 11,300tons '86: 14,100 〃 '87: 18,500 〃	35-40% automobile 10-15% cement 5% pump	'85: 10,000tons '86: 7,600 〃 '87:154,000 〃	'86: 140tons '87: 240 〃 '88: 290 〃	Semi-mechanized at automobile component foundries. • Defect ratio 8-10% in SMEs.
Forging	'85: 300tons '86: 800 〃 '87: 530 〃	Shafts and axis, pulleys, gears.	'85: 372tons '86: 2,550 〃 '87: 246 〃	none none none	• Technologies for forging dies are essential
Electroplating	n.a	Automobile, furniture domestic appliances and tools	n.a	n.a	Defect ratio 5-30%. Waste water treatment are not available Functional plating are few. Training institutes are few and poor facilities.
Sheet metalwork and welding	n.a	SMEs and MEs for construction elements LEs & Med-Es for plants and heavy machinery 6-38mm thick	n.a	n.a	• Technology gap is large between SMEs and LEs & MEd-Es. • SMEs: Manual operation, mostly use chisels poor quality in welding • LEs: Semi automation, partly used CO2 and TIG welding • Training institutes: SENAs basic : Don Bosco: basic & CO2 : Welding material supplier: advanced tech.
Machining	n.a	Whole the industry	n.a	n.a	SMEs and MEs mostly equipped with old few machines and without gear cutting machine, grinder and boring machine. With few measuring instruments and no concept on tolerance and accuracy
Machine assembly	n.a	Automobile and motorcycle, phone, exchanger, elevator and electric machiney and equipment and many sub sectors	n.a	n.a	• Limited to LMEs • Technical cooperation with overseas. • Poor in engineering and design • Testing and inspection depended on out-house institutes. • Development of SMEs sub-contractors is essential.
Pressworks	n.a	Large products for automobile sector Small-medium for electric appliances and canning industry	n.a	n.a	• Hydraulic press under 1000tons, mechanical under 600tons, 1.0-0.2mm thick. • Dies and tools made in-house by milling, shaping and drilling machines • Precision dies are not available • Heat treatment depends on out-house. • Most facilities are second-hand.

Table 3.99 TECHNICAL AND MANAGERIAL LEVEL FOUND BY THE QUESTIONNAIRE SURVEY

Technical and Managerial Factor	Level	Medium Scale 50-199P	Small Scale 11-49P	Micro Scale 6-10P	Micro Scale 2-5P
Educational background of top management	University	82 %	42 %	20 %	14 %
	SENA	6	14	15	31
	Vocational school	6	26	15	17
	Secondary school	6	5	17	14
	Primary school	0	4	17	8
	Others	0	9	16	16
Composition of employees	Managerial and administration	20	18	18	18
	Engineer	12	17	11	21
	Qualified technician	32	35	50	41
	Unqualified technician	36	30	21	20
Average working period	Less than 1 year	1.3	5.0	12	31
	1 - 2	22.3	14.5	42	36
	3 - 5	47.7	69.0	32	28
	6 -10	24.0	7.0	12	0
	Over 10 years	4.7	4.5	2	5
Average No. of machines owned		20.3 units	10.3 units	8.46units	6.03units
Average period of machines used		7.5 years	10.3 yrs	5.69 yrs	4.36yrs
Operation ratio of machines	71 -100 %	21.8 %	35 %	47.1 %	32.4 %
	51 - 70	73.3	48.4	17.7	37.9
	31 - 50	4.5	13.4	23.5	29.7
	0 - 30	0	5.8	11.7	0
Quality required by clients	Easy to satisfy	15.2 %		14.8 %	
	Acceptable	65.2		70.4	
	Not acceptable	19.7		14.8	
Delivery requested by clients	Easy	4.4		3.5	
	Acceptable	61.8		68.4	
	Too strict	33.8		28.1	
Reason for difficulty	Insufficient labor force	12.5 %			
	Insufficient production caps.	34.4			
	Inadequate production planning	6.3			
	Technical difficulties	25.0			
	Others	21.9			
Obtaining of materials	Easy to obtain	78.5 %	74.5 %	77 %	83 %
	Difficult to obtain	22.5	25.5	23	17
Reason for difficulty	Production area of materials is far	11.0 %	12.5 %	11 %	10 %
	Difficulty to get imported materials	24.0	23.5	22	20
	Demand is over supply	8.3	26.5	17	15
	Poor quality of domestic products	45.7	23.0	28	35
System of quality control	None	1.0 %	0.5 %	7 %	3 %
	Check when trouble occured	3.3	35.5	42	35
	First product inspection	34.3	28.0	25	19
	Simple check list with sampling	10.0	20.0	12	16
	Control charts	29.0	9.0	4	3
	Others	22.3	6.5	10	24
Defect ratio of products	Over 20 %	0 %	0 %	0 %	0 %
	11 - 20	7.2	2.0	3.0	6.0
	6 - 10	4.7	20.0	20	16.0
	Under 5	87.7	78.0	77	78
Production planning method	No schedule	2.3 %	8.5 %	20 %	22 %
	Rough schedule by experience	27.7	64.5	55	57
	Man-hour distribution	21.0	6.0	8	8
	Man-hour togethr with utilization ratio	28.5	11.0	12	8
	Others	30.0	10.0	5	5
Technical level of workers	High	55.3 %	7 %	17 %	14 %
	Middle	42.6	74.5	73	78
	Low	2.0	18.5	10	8
Drawing supplied	By yourself	87.6 %	50 %	59 %	69 %
	By clients	7.7	46.5	34	25
	Others	4.3	3.5	7	6
Understanding technical drawing	Non	1.3 %	2 %	7 %	11 %
	1 person	3.7	32	34	32
	2 - 4	10.3	30.5	59	54
	5 -10	21.6	21.0	3	0
	More than 11	63.3	15.0	0	0
Application for industrial standard	Non application	1 %	4.5 %	3 %	8 %
	Client's standard	31	39	50	30
	Firm's standard	15.6	24	32	41
	National standard	30.0	15	13	8
	International standard	22.3	11	3	11
	Others	0	6	0	3

Table 3.-100 PROMISING PRODUCTS AND TECHNOLOGY LEVEL

(1/2)

◎ : Possible by existing technology level
○ : Required technological improvement in addition to existing technologies
△ : Required revolutionary improvement in technology and facilities
* : Preferable to import

		Casting				Forging		Heat treatment				Welding				Material testing				Forming	
		Ordinary cast iron	Quality cast iron	Cast steel	Non-ferrous casting	Free forging	Die forging	Quenching & tempering	Case hardening	R.F. induction hardening	Special heat treatment	Cutting	Ordinary welding	Thick plate welding	Special alloy welding	Chemical analysis	Microscopic analysis	Physical testing	Non-destructive testing	Sheetwork (thin plate)	Presswork (thick plate)
Repair and Components for Agricultural and Construction Equip.	Stationary	◎	△	○	○	○	△	○				◎	◎	○				○	○	○	○
	Rotationary	–	–	–	–	○	△	○	○	○	–	–	–	○	–	–	○	○	◎	–	○
Repair and rebuilding of machine tools	Bed Frame	○	△									◎	◎	○				○	○	○	○
	Moving parts	–	–	–	○	○	△	○	○	△	△	–	–	○	△	○	○	○	○	–	–
Mold and die for plastic and press	Body	–	–	○	–	○	–	○	○	○	△	○	–	–	–	△	△	○	○	–	–
	Accessory	–	–	–	–	–	△	○	○	○	△	◎	–	–	–	–	–	○	○	–	–
Pump and valve	Casing	○	○	△	△	–	–	○	–	–	–	–	–	○	–	○	○	○	△	–	–
	Rotor	–	○	△	△	○	–	○	–	–	○	–	–	–	–	○	○	○	○	–	–
Plastic injection and extrusion machine	Stationary	◎	○	○	○	○	–	○	–	–	–	–	◎	○	–	–	–	○	○	◎	○
	Movable	–	○	○	–	–	–	○	○	△	–	○	○	○	–	–	○	○	○	–	○
Automobile components	Stationary	○	○	△	○	–	–	○	–	–	–	◎	○	○	△	–	–	○	○	○	○
	Movable	–	–	–	–	○	△	○	△	△	–	–	–	○	–	–	○	○	○	–	–
Electric Home Appliances	Stationary	◎	–	–	○	–	–	○	–	–	–	◎	○	○	○	–	–	○	○	○	○
	Movable	○	○	–	○	–	△	○	○	○	–	◎	○	–	○	○	–	○	○	○	○
Electric Motor	Stationary	◎	○	–	–	–	–	○	–	–	–	○	◎	○	–	○	–	○	○	◎	○
	Movable	–	–	–	–	○	–	○	–	○	–	○	◎	–	○	○	○	○	△	○	–
Furniture	Metal	◎	–	–	○	–	–	–	–	–	–	○	○	–	–	–	–	–	–	○	–
Basic components : Shaft, Pin, Gear, Shank		–	○	△	–	○	△	○	△	△	–	◎	–	–	○	○	○	○	○	–	–
Sprocket wheel, V-belt wheel, Pipe joint		–	○	○	○	–	–	○	–	△	–	◎	○	○	–	○	–	○	○	–	○
Two wheel walking tractor	Stationary	○	○	–	–	○	–	○	–	–	–	◎	○	○	–	–	–	○	○	○	○
	Rotating	–	–	–	–	○	△	○	○	△	–	○	–	–	–	○	○	○	○	–	–
Simple machine tool	Bed Frame	○	△	△	–	○	–	△	△	△	–	○	○	○	–	–	–	○	○	○	△
	Movable parts	–	–	△	–	○	△	○	○	○		○	–	–	–	○	○	○	○	–	–
Precision and large mold and die	Body	–	–	△	–	△	△	△	△	△	△	○	–	–	–	△	△	○	○	–	–
	Accessory	–	–	–	–	○	–	○	○	△	△	○	–	–	–	○	○	○	○	–	–
High pressure and large pump and valves	Casing	○	△	△	△	–	–	○	–	–	–	–	–	–	–	○	△	○	△	–	–
	Rotor	–	–	–	△	○	△	○	△	△	–	–	–	–	–	△	△	○	△	–	–
Diesel Engine	Stationary	–	△	△	△	○	–	△	–	–	–	–	–	○	–	○	○	○	△	–	○
	Rotating	–	–	○	–	△	△	○	△	△	–	–	–	–	–	△	△	○	○	–	–
Major components for automobile	Stationary	○	△	△	△	○	△	△	○	△	–	○	○	○	△	△	△	△	○	○	△
	Movable	–	–	△	–	△	△	△	○	△	△	○	○	△	△	△	△	△	△	–	△
Hydraulic machinery components	Body	○	△	△	△	–	△	○	△	△	–	○	○	△	△	○	△	○	○	–	○

◎ : Possible by existing technology level

○ : Required technological improvement in addition to existing technologies

△ : Required revolutionary improvement in technology and facilities

* : Preferable to import

		Machining							Measurement			Plating & painting				Basic components								Software		
		Cylindrical cutting	Plane cutting	Cylindrical grinding	Surface grinding	Drilling and boring	Gear and spline cutting	EDM and wire cut EDM	Dimensional measuring	Position measuring	Profile measuring	Ordinary electroplating	Functional plating	Plastic plating	Painting	Bearings	Shaft and pin	Gear and spline	Oil seal and O-ring	Die and mold	Hydraulic equipment	Electric and electronic comp.	Raw materials	Engineering & Design	Production control	Quality control
Repair and Components for Agricultural and Construction Equip.	Stationary	◎	○	—	○	○	—	—	○	○	—	○	—	—	○	—	—	—	—	○	—	○	○	○	○	○
	Rotationary	◎	◎	○	○	○	△	—	○	○	—	—	△	—	—	*	○	△	—	—	*	—	○	○	○	○
Repair and rebuilding of machine tools	Bed Frame	◎	○	—	○	○	—	—	△	△	—	○	—	—	○	—	—	—	—	—	—	○	○	○	○	○
	Moving parts	◎	○	○	—	○	△	—	○	○	△	—	△	—	—	*	○	△	—	—	*	—	△	△	○	○
Mold and die for plastic and press	Body	—	○	—	△	○	—	△	○	○	△	—	△	—	○	—	—	—	—	—	—	—	○	△	○	○
	Accessory	◎	○	○	○	○	—	—	○	—	○	○	△	—	—	*	○	—	—	—	—	—	○	△	○	○
Pump and valve	Casing	—	○	—	○	○	—	—	○	○	○	—	—	—	○	—	—	—	—	△	△	—	○	○	○	○
	Rotor	○	○	○	△	○	△	—	○	○	△	—	△	—	—	*	○	△	—	—	—	—	○	○	○	○
Plastic injection and extrusion machine	Stationary	○	○	—	△	○	—	—	○	○	—	○	—	—	○	—	○	—	—	—	*	○ *	○	○	○	○
	Movable	◎	○	○	—	○	△	—	○	—	○	—	△	—	—	*	○	△	*	—	—	—	○	△	○	○
Automobile components	Stationary	○	○	—	△	○	—	—	○	○	△	○	△	△	○	—	○	—	*	○	*	○ *	○	○	○	○
	Movable	○	○	△	—	○	△	—	○	○	△	—	△	—	—	*	△	△	—	—	—	○ *	○	○	○	○
Electric Home Appliances	Stationary	◎	◎	—	○	◎	—	—	◎	◎	—	◎	—	△	○	—	—	—	—	○	*	○	○	○	○	○
	Movable	◎	○	○	○	○	—	—	○	—	—	—	○	—	○	*	○	○	*	○	*	○	○	○	○	○
Electric Motor	Stationary	◎	◎	—	○	◎	—	△	○	○	—	○	—	—	○	—	—	—	—	○	—	○	○	○	○	○
	Movable	◎	○	○	—	○	△	—	○	○	○	○	△	—	○	*	○	—	*	△	—	—	○	○	○	○
Furniture	Metal	—	○	—	○	◎	—	—	◎	○	—	○	—	○	○	—	—	—	—	○	—	—	○	○	○	○
Basic components : Shaft, Pin, Gear, Shank Sprocket wheel, V-veit wheel, Pipe joint		○	○	○	—	○	△	—	○	○	△	—	△	—	—									○	○	△
		○	○	○	—	◎	—	—	○	○	△	○	—	—	○									○	○	△
Two wheel walking tractor	Stationary	◎	○	—	○	○	—	—	○	○	—	○	—	△	○	—	○	—	*	△	△	○ *	◎	○	△	△
	Rotating	◎	—	△	—	○	△	—	○	○	—	—	△	—	—	—	○	△	*	—	—	—	△	△	△	△
Simple machine tool	Bed Frame	○	△	—	△	△	—	—	△	△	—	○	—	—	△	—	○	—	*	—	△ *	△ *	○	△	△	△
	Movable parts	○	—	△	—	○	△	—	○	△	△	—	△	—	—	*	△	△	—	—	—	—	△	△	△	△
Precision and large mold and die	Body	○	○	△	△	○	—	△	○	△	△	—	△	—	—	—	—	—	—	—	—	—	△	△	○	△
	Accessory	○	—	○	—	—	—	—	○	—	△	—	△	—	—	*	○	—	*	—	△	—	○	△	○	△
High pressure and large pump and valves	Casing	—	○	—	○	○	—	—	○	○	△	○	—	—	○	—	—	—	*	△	△ *	—	○	△	○	○
	Rotor	○	—	△	—	○	△	—	△	○	△	—	△	—	—	*	△	△	—	—	—	—	△	△	○	△
Diesel Engine	Stationary	○	○	—	△	△	—	—	△	△	—	○	—	—	△	—	—	—	*	—	△ *	△ *	○	△	△	△
	Rotating	△	—	○	—	○	△	—	○	○	△	—	△	—	—	*	△	△	—	—	—	—	△	△	△	△
Major components for automobile	Stationary	○	○	△	△	△	—	△	○	△	△	△	—	△	△	—	—	—	*	△	△ *	△ *	○	△	△	△
	Movable	△	○	△	—	○	△	—	○	△	△	—	△	—	—	△	△	△	*	△	△ *	△ *	○	△	△	△
Hydraulic machinery components	Body	○	○	△	△	△	—	△	△	○	△	○	△	○	○	*	○	—	*	△	—	△ *	○			

Table 3.101 PROGRESS STAGES OF "FOUNDRY" TECHNOLOGY

		Primitive Stage	Intermediate Stage	Advanced Stage
Management & Control	Production Control Quality Control Training of Working	• Controls at random according to the situation • Appearance inspection, Defect ratio more than 10% • Training for workers is not done	• Data collection for control • Appearance inspection, dimentional inspection color check and quality review, Defect ratio 3-6% • Training by public institutes	• Execution of schedule and quality control activity • Ultrasonic inspection systematic measure for quality defect ratio less than 3% • Planned training in-house and by public institutions
Technology and engineering		• Products FC10-FC15 • Floor molding • Simple shaped products • Natural sand • Manual mixing	• FC15-FC30, carbon cast steel • Application of casting design • Mixing natural and synthetic sand • Smooth product surface • Good maintenance of wooden patterns	• Alloy cast iron, carbon cast steel, alloy cast steel, stainless casting and ductile • Job order by casting design • Control of synthetic sand melting metal, pattern and materials
Production	Skill	• Produced by experienced workers • Temp. control by visual and perception	• Measuring melting by instrument • Control mixing sand • Weighing of raw material	• Control of melting metal and data recording • Control and data records of synthetic sand
	Facilities	• Melting equipment only for melting • Manual and simple finishing	• Melting equipment with adjustment of air pressure and volume • Arc furnace, L.F. furnace. • Shot blast, sand recovery mashine, molding machine shakeout machine • Good maintenance	• Avc furnace, L.F. and H.F. furnace, • Temp. control of recovered sand.
Working Condition and Pollution Control		• Gloom working place • Insufficient measure against dust.	• Improved lighting • Dust collector • Use of safety protector	Same as the left

Table 3.102 PROGRESS STAGES OF "FORGING" TECHNOLOGY

Contents of Technology		Primitive Stage	Intermediate Stage	Advanced Stage
Management and Control	Production Control Quality Control Training of Workers	• Control at random according to the situation • Materials out of regulation • Appearance inspection • Training is not done	• Data collection for control • Dimensional check and penetrating check • Certified material • O J T	• Conduct of schedule and quality control activity • Magnetic particle and ultrasonic inspection • Certificated materials • Systematic training
Engineering and Technology		• Forged by hammer, flatter and tup • Simple shaped products • Uncertain material	• Free forge by hammer and press • Die forge by hammer and press • Control of heating temp. • Die design • Heat treatment after forge • Selection of material	• Free forge and die forge by hammer and press • Die design • Die making and control • Control of heating temp. and heat treatment
Production	Skill	• Production by experienced perception • Temp. control by visual and perception	• Material control • Temp. control of material and die • Quenching and tempering of forged product • Trimming	• Material control and data recording • Data recording of heat treatment
	Facilities	• Hammer, tongs, tup, floor furnace with manual or foot blower, rasp and file	• Hammer, press • Heating furnace • Trimming press • Shotblast • Sawing machine	• Hammer and press • Manipulator • Continuous heating furnace • Heat treatment equipment • Die making machine • Trimming press
Working condition and pollution control		———	• Protect of vibration and noise • Use of safety protector	• Same as left

Table 3.103 PROGRESS STAGES OF "MACHINING" TECHNOLOGY

Contents of Technology		Primitive Stage	Intermediate Stage	Advanced Stage
Management and Control	Production Control Quality Control	• Visual check • Site adjustment of dimensions • Countermeasure after occurrence of trouble • Defect more than 9% • Check sheet not available	• Visual check and dimensional check with instruments • Application for primitive Q.C. • Check sheet available • Defect ratio 4 - 8% • Interchangeability of partial components	• Application for statistical quality control • Completion of prevention and feed-back system against defect and error • Defect ratio less than 3% • Interchangeability of almost all components
Engineering and Technology		• Main works by lathe • Simple works by shaper and drilling machine • Measurement by calipers	• Works by turret lathe • Standards of relationship among accuracy, available tools and procedure • Selection of cutting oil • Standardization of cutting conditions	• Application for tool grinder • Selection of processing method according to machine's characteristics and appropriate machine layout • Application for copy machining • Jig design • Full use of NC machines
Skill		• Available for manual of making center hole	• Use of rotary table and index plate • Protection of machine vibration • Selectire use of milling machines • Machine threading	• Apprication manual for H.S. steel bits and special alloy steel bits • Use of dial gauge and maintenance • Use of clearance gauge • Use of copy machining • Reaming
Points of Machining Works Experimental		• Use of simple measuring instrument • Manuals of marking	• Use of calipers and micrometer • Work setting on machine tool	• Tool control by specialist
Knacks mastered through Experiences		• Knacks for using heel bites	• Knacks for using measuring tools • Judgement of tool wear	• Knacks for using jig and fixture
Working Environment		• Work without protector • Disorderly and dirty workshop • Gloom workshop • Insufficient Ventilation	• Protector and safety device available • Orderly and clean workshop partly used pallet • Light workshop • Well ventilated by electric fan and exhaust fan	• Completely equipped with protector, safety device • Using pallet for arrangement on appointed place • Sufficiently lighted • Equipped with fixed fan, machanical ventilation and air-conditioned in offices and rest rooms

Table 3. 104 PROGRESS STAGES OF "MACHINE ASSEMBLY" TECHNOLOGY

Contents of Technology	Primitive Stage	Intermediate Stage	Advanced Stage
Management and Control Production Control Quality Control	• Visual check and site adjustment • Countermeasure after occurrence of trouble • Defect ratio over 9% • Check sheet not available	• Dimension control by measuring tools • Application for primitive Q. C. system • Check sheet available • Defect ratio 4 - 8% • Partly interchangeability of components	• Application for statistical quality control • Defect and error less than 3% by completion of protection and feed-back system • Running test • Most components interchangeable
Engineering and Technology	• Simple assembly with bolt, nut, flange, washer and gasket • Manuals for selection and application of bolt, nut, washer, flange, etc.	• Assembly of key, cylinder valve, chain, belt • Standards for selection and usage of key, cylinder valve, chain and belt • Selection of stopper loosening of bolt and nut • Selection of cleaning components	• Assembly according to drawings • Application for fitting allowance and talerance • Assembly of gear and bearing • Assembly with reamed hole and body-bound bolt • Assembly with hydraulic technique
Skill	• Selective usage of tools and jigs • Selection and usage of rasp and file • Selective use of tips and dies	• Procedure of assembly • Usage of stud bolts • Engagement of keys • Assembly of chain and belt	• Application for torque wrench • Layout of ass'y shop • Assembly without hand finishing or return to machining • Application for chock liner • Alignment and centering
Experimental Points of Assembly Work	• Correct usage of hand tools like spanner and screw driver • Usage of packings and seals	• Selection and usage of ass'y tool and jig • Fastening double nuts	• Assembly by specialized workers in assembly • Combination of shims • Usage of rings
Knacks mastered through Experience	• Hand finishing by file • Tapping and threading by hand tap and dies • Usage of wooden and lead hammer • Fastening of bolt and nut	• Knacks of extention allowance	• Procedure of alignment • Development and renovation of assembling specific jigs • Adjustment at site of chock liner
Working Environment	• Works without protector • Disorderly and dirty in workshop • Insufficienily ventilated	• Usage of protector and safety device • Orderly and clean in workshop partly used pallet • Light workshop • Well ventilated by electric fan and exhaust fan	• Completely equipped with protector, safety device • Using pallet for arranging components at appointed place • Sufficiently lighted • Equipped with fixed fan and ventilator and air-conditioned in offices and rest rooms

Table 3.105 PROGRESS STAGE OF "PLATE WORK AND WELDING" TECHNOLOGY

Contents of Technology		Primitive Stage	Intermediate Stage	Advanced Stage
Skills	Tools and Jigs	• Selective use of scale, roll scale • Marking procedure • Usage of hand tools like hammer and chisel • Manual of gouging • Usage of sheetmetal working tool and jigs	• Manuals of mold lofting • Procedure of plate cutting • Relation of bending radius and plate thickness • Usage of grinder	• Reading of production dwg. • Keeping job instruction manual
	Facilities	• Usage of shearing machine • Usage of drilling machine • Simple procedure assembled by bolts	• Usage of sheet metalworks machines like nippler, shearing machine, roller and folder • Usage of plateworking m/c like shear, bending and roller • Usage of jigs for material cutting, assembling and welding • Procedure of stainless steel working	• Operation of press brake • Welding turn table • Gouging device
	Gas	• Usage of gas • Manuals of gas cutting • Soldering	• Managing of acetylene gas generator • Usage and control of manual gas cutter • Gas cutting of multi-piled plates • Edge preparation of thick plate • Gas welding • Brazing for low strength	• Stress relief • Appropriate control of torch • Usage of semi-automatic and full automatic gas cutting machine • NC gas cutting machine • Control of welding torch tip • Hand brazing
	Electric Welding	• Flat welding • Fillet welding	• Vertical welding • Overhead welding • Overlay welding (2 - 3 layers) • Rod operation and arc stability • Flange welding • Thin plate welding • Gravity welding • Protection device against electric shock	• Maintenance of arc welders • Auto submerged arc welding (horizontal flat) • Automatic flat welding • Automatic horizontal welding • Automatic vertical welding • TIG weldig on thin plate under 3mm and alloy steel • MIG welding on thick plate over 3mm with Ar gas • CO2 arc welding • Electro gas welding • Electro slug welding • Welding of special alloy steel like stainless steel • Spot welding and seam welding • Application of robotic welder
Inspection		Visual check by welder	• Welding defect inspection by penetrating check, and taken countermeasure	• Welding defect inspection by X-ray, ultrasonic and magnaflux flaw detector • Physical testing
Technology		Multi-overlay fillet welding	• Job instruction by simple dwg. • Selective usage of gas and arc welding • *Edge preparation for manual* welding • Overlay on edge preparation • Welding procedure manual	• Job instruction by drawing • Welding manual based on accuracy control • *Flat welding for overhead and* horizontal welding by turn table • Material application manual • Improved welding procedure by drawing review • Edge preparation for automatic *welding* • Application standards of electrodes • Job manual • Comparative study on cost and time by welding method including MAC
Working Environment		• Working without protector • Bad arrangement and cleaness • Gloomly lighted • Insufficiently ventilated	• Working with protector and safety tool • Arranged but not used pallet • lighted enough • Ventilated naturally or by *movable fan*	• Completely equipped with protector, safety tool and device • Well arranged at appointed places on pallets • Sufficiently illuminated by *mercury lamp* • Well ventilated by fixed fan and mechanical ventilator • Air-conditioned in offices and workers house

Table 3.106 PROGRESS STAGE OF "PRESS WORK" TECHNOLOGY

Contents of Technology		Primitive Stage	Intermediate Stage	Advanced Stage
Management & Control	Production Control, Quality Control, Training of workers, Etc.	• Usual delay of delivery • Rough production planning and cost control • Not quite education nor training • Random visual inspection	• Delivery delaying sometimes • Clarified production control with tables and lists • Visual inspection and dimensional inspection with samples	• No delay of delivery • Production planning considering load distribution, etc. and adjustable by its feedback system • Established education and training • Adoption of statistical quality control
Technology		• Products accuracy of min. 1mm. Measurement with scales or calipers • Mainly shearing and bending of sheet plates as press work • Molds and dies of low class materials and of short life	• Products accuracy of 0.9 to 0.2mm. Measurement with vernier calipers • Shearing and simple punching with large shearing machine as press work • Design and fabrication of simple molds & dies • Estimation of springback and mold design considering it	• Products accuracy of about 0.1mm Use of micrometer, dial gage, special gages as necessary • Workable of plates and sheets • Complex working with double acting press, oil hydraulic and hydraulic press • Solution of wrinkles and deformation
Production	Skills & Facilities	• Workers not capable of working without instructions nor understanding drawings • Not capable of changing mold cutters • Use of small foot press • Use of small shear • Repair only when troubled. Not more than 50% of utilization ratio • Not less than 10% of fraction defective	• Workers capable of working with drawings or brief instructions • Appropiate selection of presses and shears • Molds rust-prevented and kept on shelves • Use of large presses, cranked presses, machine presses, etc. • Checking machinery even when not troubled • 4 to 10% of fraction defective	• Workers capable of fitting complicated molds. • Periodical checking, recording and controling of machinery • Use of compound press and transfer press • Periodical maintenance and checking of machinery • Not less than 80% of machinery utilization ratio • Not more than 3% of fraction defective
Working conditions & Pollution control		• No safety devices provided • Affecting noise and vibration to neighbour	• Simple safety devices provided • Antivibration devices provided to machinery foundation • Adequate lighting	• Obliged to provide safety devices and tools • Established integral measures against noise and vibration

Table 3.107 PROGRESS STAGE OF "ELECTROPLATING" TECHNOLOGY

Contents of Technology		Primitive Stage	Intermediate Stage	Advanced Stage
Management & Control	Production Control, Quality Control, Training of workers, Etc.	• Random visual inspection only • Not less than 20% of fraction defective • Not quite education nor training	• Visual inspection and adhesion control • 6 to 20% of fraction defective • OJT by foremen's judgement	• Quantative (statistical) quality control • Not more than 5% of fraction defective • Systematic education & training
Technology		• Not strict film thickness such as tin and zinc galvanizing • Rough control of solution • No measures against defects • Rough pretreatment and post treatment	• Capable of plating aluminium, chromium, nickel, etc. • Periodical control of solution • Adequate treatment of degreasing and derusting • Positive attitude for defects	• Hard chromium plating, multilayer plating • Qualitatively controlable and measurable film thickness • Standardized and documentalized plating conditions • Usual studies on new technologies and practices
Production	Skills	• Workers not capable of working without foremen's instructions.	• Workers capable of preparing and working except new jobs. • Workable with simple work instructions.	• Workers capable of deciding preparation, work contents and plating conditions • Standardized work.
	Facilities	• Pretreatment by manual derusting and degreasing with soap • Wooden plating tank • Water rinsing after plating in water tank used in common with plating • No recovery of solution	• Mechanical derusting, degreasing and deoxidation with chemical solution • Plating tanks of suitable materials and sizes to the purpose • Controlable device of plating solution • Separate water rinsing tank changing water timely with recovery tank	• Double or triple degreasing, derusting, etc. • Automatic control of solution • Filtering, agitation and water purification devices • Water rinsing, hot water rinsing, hot air drying and infrared rays drying
Working conditions & Pollution control		• Inadequate lighting and ventilation • Rough handling of chemical solution • Direct discharge of non-treated waste water	• Simple waste water treatment • Knowledge of treatment on chemicals and high electric current	• Usual control of safety and hygiene in shop and of waste water by controller of safety and pollution

3.4 Current Situation of Steel Industry

This section examines the current situation of the steel industry - a major source of raw material supply to the metalworking industry - and steel market trends including exports and imports.

3.4.1 General Background of Steelmaker

In Colombia, there is one integrated steelmaker, 5 electrical furnace makers, and a number of rolling mills. In addition, there are 3 companies doing surface treatment (zinc plating and tinning) of imported steel plates and sheets. Production facilities and capabilities of these makers are described as follows.

(1) Paz del Rio steel plant (Acerias Paz del Rio - APDR)

This steel plant is located in Belencito in the Department of Boyaca. It is the only one integrated steel production facility in Colombia and manufactures steel bars, plates and sheets, although qualities and types of steel plates and sheets are rather limited. The company uses auxiliary materials as iron ores, coals, and limestone produced at the own mines.

1) Facility outline

a) Blast furnace	:	1 unit with production capacity of 930 tons daily and 340,000 tons annually
b) L.D. converter	:	2 units with production capacity of 340,000 tons annually each
c) Electric furnace	:	1 unit with production capacity of 40,000 tons annually
d) Bloom rolling mill	:	1 unit; 250mm x 250mm; production capacity of 400,000 tons annually

e) Billet rolling mill : 1 unit; 70mm x 70mm; production capacity of 280,000 tons annually

f) Bar rolling mill : 1 unit with production capacity of 180,000 tons annually

g) Steckel mill : 1 unit with production capacity of 300,000 tons annually

h) Coke furnace : 1 unit with production capacity of 365,000 tons annually

i) Sintering equipment : 1 unit with production capacity of 400,000 tons annually

j) Oxygen supplier : 1 unit

2) Major products

a) Semi-finished goods (blooms, billets, slabs, etc.)

b) Steel bars: steel sections, bars, wire rods for construction and metalworking

c) Hot rolled steel plates and sheets: 2-6 mm thick, max. 1,200mm wide

3) Major problems

a) Raw materials have poor qualities, although they can be obtained from nearby mines without much transport cost. In particular, iron content is approximately 43%, much lower than iron ores used in other countries, with iron content of between 60 and 63%.

b) Ingot containers and rollers are deteriorated due to aging, resulting in low efficiency and requiring large amounts of electricity and manpower.

c) Rolling mills are old, not capable of satisfying quality requirements and require high operating costs.

(2) Medellin steel plant (Siderurgica de Medellin - SIMESA)

This steel plant is located in Medellin in the Department of Antioquia. It is the first steel plant in Colombia, constructed in 1938.
The plant has an electrical furnace, continuous casting equipment (production capacity of 150,000 tons annually each) and a bar rolling mill (130,000 tons annually), and manufactures steel bars, drawing wires, welded pipes, and cast and forged steel products.

(3) Pacifico steel plant (Siderurgica del Pacifico - SIDELPA)

The plant was established in 1961 in Yumbo, Cali in the Department of Valle. It started steel production in 1963 and has been manufacturing special steel products since 1969. Like the SIMESA, the plant has an electrical furnace (production capacity of 100,000 tons annually), continuous casting equipment (production capacity of 120,000 tons annually) and an bar rolling mill (100,000 tons annually), manufacturing steel bars.

(4) Boyaca steel plant (Siderurgica Boyaca - SIDEBOYACA)

This steel plant is located in Tuta in the Department of Boyaca. It is equipped with an electrical furnace, continuous casting equipment (production capacity of 120,000 tons annually each) and a bar rolling mill (160,000 tons), manufacturing steel bars.

(5) Muna steel plant (Siderurgica del Muna - SIDEMUNA)

The plant is located in Bogota in the Department of Cundinamarca. It was first established in 1947 as an iron foundry to supply gray cast iron ingots to APDR

until 1953 when being taken over by SIMESA. An electrical furnace was built after replaced to SIMESA and started to produce small section bars in 1958. In 1964, the plant boosted production of round bars by using blooms supplied by APDR. In 1972, SIMESA sold the plant's stocks to SIDEMUNA. At present, it owns an electrical furnace (production capacity of 130,000 tons annually), continuous casting equipment (production capacity of 150,000 tons annually) and a bar rolling mill (150,000 tons annually) like SIMESA, manufacturing steel bars and welding wires.

(6) Caribe steel plant (Siderurgica del Caribe - SIDECARIBE)

SIDECARIBE is located in Cartagena in the Department of Atlantico and started operation in 1989. The plant has an electrical furnace (production capacity of 100,000 tons annually) and a rolling machine (60,000 annually), which was originally owned by SIDEBOYACA.

(7) Plants specialized in rolling mills

Rolling mills mainly manufacture reinforcement bars for construction work by purchasing billets from the outside. They are small in scale and equipped with second-hand machinery, and are characterized by labor intensive and low quality makers, as compared to the electric furnace makers. Some of them own small electrical furnaces (Acerias Bogota, Siderurgica del Occidente, Siderurgica del Norte, Siderurgica Sogamoso, and Siderurgica Nacional), but together with other mills (Corradine, Heliacero, Fundente, Bulcanos, Laminados Muza, and Laminados Andinos), they are specialized in rolling of reinforcing bars for concrete work.

(8) Holasa (Hojalata y Laminados S.A.)

It is located in Medellin in the Department of Antioquia. The mill is specialized in surface treatment of

imported steel plates and sheets to manufacture tinplate and chromium-plated plates and sheets. Although the mill is not classified as a steel plant, it is included here as a steel production facility.

1) Production capacity: 70,000 tons annually
2) Major products : Containers for foods, beverages, lubricants, etc.
3) Sizes : Up to 930mm in width and 0.16 to 0.30mm in thickness

(9) Colombia steel mill (Acerias de Colombia S.A. - ACESCO)

This plant is located in Barranguilla in the Department of Atlantico. Like Holasa, the plant is specialized in tin plating of imported steel plates, sheets and pipes.

1) Production capacity: 40,000 tons annually
2) Raw material : 1.2m in width, 0.2 to 2mm in thickness

(10) Corpacero steel mill (Corporacion de Acero Marco y Srendi y Cia - CORPACERO)

This mill is located in Bogota in the Department of Cundinamarca. Like Holasa, it is specialized in zinc plating of imported steel plates, sheets and pipes.

1) Production capacity: Zinc plated sheets - 30,000 tons annually
Zinc plated pipes - 20,000 tons annually
2) Plating method : Hot dipping

Combined production capacities of above plants are 880,000 tons annually, and 340,000 tons by converters and 540,000 tons by electrical furnaces.

3.4.2 Domestic Steel Production

(1) Crude steel (Unit: 1,000 tons)

1) Trends in crude steel production are as follows:

	1984	1985	1986	1987	1988
Crude steel production	507	530	632	694	700

2) Production at major steel plants in 1988 is summarized as follows:

	APDR	SIMESA	SIDELPA	SIDEBOYACA	SIDEMUNA	OTHERS	TOTAL
Crude steel production	343	100	56	115	57	16	687

(including 305,000 tons manufactured by converters)

Source: Reestructuracion del sector siderurgico - Diagnostico dinamico - junio de 1989

The crude steel output has been increasing steadily, but has remained at a 700,000-ton level in the last few years. Capacity utilization rates of converters and electrical furnaces in 1988 were as follows:

Converters : 305/540 = 91%
Electrical furnaces: 382/540 = 71%

(2) Production by final products

1) Production trends in steel products made from locally manufactured crude steel

Unit: 1,000 tons

	1980	1981	1982	1983	1984	1985	1986	1987
Steel plates and sheets	13.2	10.7	19.7	32.8	31.1	34.9	40.3 (42.4)	37.0 (38.5)
Bars	289.2	282.2	288.3	326.9	366.6	394.2	406.9 (412.9)	450.9 (468.5)
Special steels	21.4	21.2	17.9	13.6	20.8	24.6	23.7 (11.0)	27.5 (25.6)
Steel pipes	-Included in imported steel materials-							
Total	323.8	314.1	325.9	373.3	418.5	453.7	470.9 (466.3)	515.4 (532.6)

Source: Reestructuracion del sector siderurgico -Diagnostico dinamico- junio de 1989

Figures in ( ) were obtained from DANE Anuario de Industria Manufacturera.

2) Production trends in steel products made from imported steel materials

Unit: 1,000 tons

	1980	1981	1982	1983	1984	1985	1986	1987
Surface treated	54.8	56.2	65.3	75.0	85.6	97.5	89.3 (89.4)	80.2 (104.6)
Steel pipe	20.4	31.2	29.8	26.6	32.0	27.4	40.3 (40.2)	41.4 (47.4)
Total	75.2	87.4	95.1	101.6	117.6	124.9	129.6 (129.6)	121.6 (152.0)

Source: Reestructuracion del sector siderurgico -Diagnostico dinamico- junio de 1989

Figures in ( ) were obtained from DANE Anuario de Industria Manufacturera.

3) Domestic production of steel products

The combined total of the above 1) and 2) is as follows:

Unit: 1,000 tons

	1980	1981	1982	1983	1984	1985	1986	1987
Total steel production	399.0	401.5	421.0	474.9	536.1	578.6	600.5 (595.9)	637.0 (684.6)

The production in 1988 is estimated at around 700,000 tons to continue stable growth.

4) Production, capacity and utilization rates at major steel plants in 1988

Unit: 1,000 tons

	Name of plant	Production in 1988	Capacity	Utilization rate (%)
Steel plates and sheets	ADPR	45.0	300	15
Bars	ADPR	162.0	180	90
	SIMESA	90.8	130	70
	SIDELPA	59.2	100	59
	SIDEBOYACA	107.8	160	67
	SIDEMUNA	53.0	150	35
Total		472.8	720	66

The reason for the low capacity utilization rate for steel plates and sheets seems to be due to shortage of semi-finished products (slabs). As for steel bars, notable are the high utilization rate at ADPR and the low rate at SIDEMUNA that appears to be caused by deterioration of machinery due to aging.

3.4.3 Steel Imports (Unit: 1,000 tons)

(1) Changes in import of final products

Recent trends in import of final products are as follows:

Unit: 1,000 tons

	1975	1985	1986	1987
Steel plates				
Hot rolled	42.9 (19%)	42.4 (7%)	51.2 (11%)	37.9 (9%)
Cold rolled	118.7 (54%)	229.3 (39%)	244.0 (52%)	56.8 (63%)
Special steel	8.7 (4%)	18.2 (3%)	19.9 (4%)	17.9 (4%)
Total	170.3 (77%)	289.9 (49%)	315.1 (67%)	312.6 (76%)
Steel bars				
Bars	8.4 (4%)	16.8 (3%)	37.9 (8%)	31.0 (8%)
Section bars	5.5 (3%)	4.2 (1%)	6.3 (1%)	13.7 (3%)
Wire rod	11.7 (5%)	13.4 (2%)	11.7 (2%)	19.1 (5%)
Total	25.6 (12%)	34.4 (6%)	55.9 (12%)	63.8 (16%)
Steel pipes	23.9 (11%)	265.6 (45%)	97.8 (21%)	32.9 (8%)
Grand Total	219.8 (100%)	589.9 (100%)	468.8 (100%)	409.3 (100%)

Source: DANE Anuario de Comercio Exterior

As seen in the table, steel plates and sheets accounted for dominant 76% of total in 1987. In particular, cold rolled sheets represented 63%. This is because Colombia does not have cold rolling plants. Imports of hot rolled sheets almost equal the domestic production. A share of imported steel bars exceeds 10% of the domestic production. Imports of steel plates and sheets, steel bars, etc. have leveled off since the early 1980s, while those of steel pipes grew in 1985 due to pipeline construction. In total, the imports have been declining since 1986.

(2) Trends in imports of raw materials for steel production

Unit: 1,000 tons

	1975	1985	1986	1987
Pig irons		1.2	0.4	0.7
Alloy irons	5.2	9.4	10.9	15.3
Scrap irons	16.5	58.1	90.5	210.1
Ships for scrap irons			31.0	
Semi-finished products	16.0	17.2	22.6	14.7

Source: DANE ANUARIO DE COMERCIO EXTERIOR

According to the Restructuring Report, import trends after 1980 are as follows:

Unit: 1,000 tons

	1980	1981	1982	1983	1984	1985	1986	1987
Alloy irons	10.1	4.2	5.7	4.8	11.7	8.7	10.4	14.7
Scrap irons	13.1	27.2	25.7	46.0	43.5	58.1	90.0	210.0
Ships for scrap irons	12.9	29.7	12.6	5.8	18.6	29.2	23.8	44.8
Semi-finished products (billets)	25.5	34.3	26.5	11.9	18.7	5.1	11.5	5.5
Semi-finished products (slabs)	15.2	22.5	23.2	16.7	8.5	11.0	10.2	7.4

Source: DANE ANUARIO DE COMERCIO EXTERIOR

Recently, imports of semi-finished products (billets and slabs) have been declining, while those of scraps recorded significant growth. This is partly because locally available scraps, estimated production of 200,000 tons annually, have relatively poor quality and their prices are fixed, and partly because capital goods and consumer durable goods are used for a long period of time, to result in relatively low supply rates of scrap irons. Of 200,000 tons of scrap irons locally manufactured, 150,000 tons are used for steel

production, and the rest for other purposes including casting. Therefore, as production of steel and other materials increases in the future, imports of scrap irons are also expected to grow. To handle imported scrap irons, SIMESA, SIDELPA, SIDEMUNA and SIDEBOYACA established SIPSA (Sociedad Industrial de Productores Siderurgicos) in 1974, which owns berths in Cartagena is responsible for import procedures, domestic transportation, and the scrapping of ships.

(3) Imports of steel products by countries (Unit: 1,000 tons)

Imports of steel products by exporting countries are as follows: (As only the top three countries in each year are indicated, blank spaces do not mean zero.)

1) Hot rolled steel plates and sheets

Unit: 1,000 tons

Exporting countries	1975	1985	1986	1987
Japan	26.8 (62%)	12.9 (30%)	12.0 (23%)	13.8 (36%)
West Germany	6.5 (15%)	4.4 (10%)	3.4 (7%)	-
United States	2.9 (7%)	-	-	-
South Africa	-	6.3 (15%)	11.3 (22%)	7.9 (21%)
Rumania	-	-	-	7.3 (19%)
Total	42.9	42.4	51.2	37.9

Source: DANE ANUARIO DE COMERCIO EXTERIOR

The imports from Japan, although on the declining trend, are still maintaining the largest share. Instead, the imports from South Africa and Rumania have been growing.

2) Cold rolled steel plates and sheets

Unit: 1,000 tons

	1975	1985	1986	1987
Japan	109.3 (92%)	158.4 (69%)	148.6 (61%)	140.8 (55%)
United States	1.5 (1%)	11.5 (5%)	-	-
West Germany	1.1 (1%)	-	15.8 (6%)	19.1 (7%)
Venezuela	-	13.2 (6%)	39.1 (16%)	39.0 (15%)
Total	118.7	299.3	244.0	256.8

Source: DANE Anuario de Comercio Exterior

The imports from Japan have decreased slightly, but still held a 50% share in 1987. In contrast, the imports from Venezuela and West Germany have been growing. In particular, those from Venezuela show notable increase.

3) Special steel plates and sheets

Unit: 1,000 tons

	1975	1985	1986	1987
Japan	5.1 (59%)	7.9 (43%)	2.9 (15%)	7.6 (42%)
United States	1.8 (21%)	-	-	-
United Kingdom	-	3.4 (19%)	3.4 (17%)	3.1 (17%)
Brazil	-	2.8 (15%)	9.4 (47%)	-
South Africa	-	-	-	2.0 (11%)
Total	8.7	18.2	19.9	17.9

Source: DANE Anuario de Comercio Exterior

In 1986, the imports from Brazil increased rapidly to take over the first place from Japan in the previous year. Then the imports from Japan increased again in 1987.

4) Bars

Unit: 1,000 tons

	1975	1985	1986	1987
Japan	5.0 (60%)	5.0 (30%)	8.6 (23%)	5.1 (16%)
Italy	0.6 (7%)	-	-	-
West Germany	0.4 (5%)	-	-	-
France	-	5.9 (35%)	12.0 (32%)	5.2 (17%)
United Kingdom	-	2.2 (13%)	4.8 (13%)	-
Venezuela	-	-	-	10.3 (33%)
Total	8.4	16.8	37.9	31.0

Source: DANE Anuario de Comercio Exterior

Venezuela was not among the top three exporting countries until 1986, but took the first place in 1987 with a 33% share.

5) Section bars

Unit: 1,000 tons

	1975	1985	1986	1987
United States	1.7 (31%)	-	0.2 (3%)	-
France	0.5 (9%)	-	-	2.7 (20%)
United Kingdom	0.3 (5%)	1.1 (26%)	-	1.6 (12%)
Poland	-	1.3 (31%)	-	-
Belgium	-	1.1 (26%)	-	-
Rumania	-	-	2.7 (43%)	-
Japan	-	-	0.4 (6%)	-
Mexico	-	-	-	2.7 (20%)
Total	5.5	4.2	6.3	3.7

Source: DANE Anuario de Comercio Exterior

As seen in the table, major export countries have been changing each year. In 1987, Mexico came in

the third.

6) Wire rods

	1975	1985	1986	1987
Japan	8.6 (74%)	4.0 (30%)	2.0 (17%)	-
France	-	-	1.6 (14%)	5.4 (28%)
United Kingdom	-	-	-	1.2 (6%)
South Africa	-	1.1 (8%)	-	-
Spain	-	2.0 (15%)	5.6 (48%)	8.1 (42%)
United States	0.5 (4%)	-	-	-
Brazil	0.7 (6%)	-	-	-
Total	11.7	13.4	11.7	19.1

Source: DANE ANUARIO DE COMERCIO EXTERIOR

The imports from Japan have declined dramatically, whereas those from France and Spain have increased.

7) Steel pipes

	1975	1985	1986	1987
Japan	10.9 (46%)	167.8 (63%)	18.1 (19%)	-
United States	5.7 (24%)	14.1 (5%)	-	-
Italy	3.2 (13%)	-	-	-
West Germanny	-	25.0 (9%)	-	-
Argentina	-	-	30.3 (31%)	8.5 (26%)
Mexico	-	-	6.7 (7%)	-
Venezuela	-	-	-	5.4 (16%)
Brazil	-	-	-	3.2 (10%)
Total	23.9	265.6	97.8	32.9

Source: DANE ANUARIO DE COMERCIO EXTERIOR

The imports have been decreasing rapidly in volume. In 1985, there was large amounts of imports from

Japan, which seemed to be due to special purposes such as oil exploration.

(4) Smuggling

It is estimated that approximately 100,000 tons of steel products being smuggled into the country annually.

3.4.4 Steel Exports

As shown below, steel exports are very small in scale in terms of items and quantities:

Unit: 1,000 tons

	1986	1987	1988
Ferro-nickel	32.3	48.4	42.7
Iron shot	-	0.3	0.3
Tinplate Sheets	-	-	2.5
Sheet zinc	1.6	1.7	1.0
Wire rods	-	0.2	0.2
Steel pipes	-	0.1	0.6

Source: DANE Anuario de Comercio Exterior

3.4.5 Steel Consumption

Steel consumption was roughly estimated by adding the domestic production summarized in 3.4.2 (2) and the imports in 3.4.3 (1) (exports not considered) as follows.

		1985		1986		1987	
Steel plates and sheet	Domestic production	157.0	13%	153.3	14%	144.7	14%
	Import	289.9	25%	315.1	30%	312.6	30%
Sub-total		446.9	38%	468.4	44%	457.3	44%
Bars	Domestic production	394.2	34%	406.9	38%	450.9	43%
	Import	34.4	3%	55.9	5%	63.8	6%
Sub-total		428.6	37%	462.8	43%	514.7	49%
Pipes	Domestic production	27.4	2%	40.3	4%	41.4	4%
	Import	265.6	23%	97.8	9%	32.9	3%
Sub-total		293.0	25%	138.1	13%	74.3	7%
Total	Domestic production	578.6	50%	600.5	56%	637.0	61%
	Import	589.7	50%	468.8	44%	409.3	39%
Grand Total		1,168.3	100%	1,069.3	100%	1,041.5	100%

Note : Locally manufactured steel plates and sheets are a sum of steel plates and sheets, special steel, and surface-treating steel in 3.4.2 (2). Therefore, surface-treating steel and steel pipes are double counted in the domestic production and the import.

Source: DANE

The recent steel demand is estimated at 1,100,000 tons, a sum of the locally manufactured and imported 1,000,000 tons and the smuggled 100,000 tons. A share of the domestic production has been increasing recently, reaching nearly 60% in 1987. If the surface-treating steel is excluded, the share was around 50% for each. Looking at major products, it is notable that 60% of steel plates and

sheets are imported, while 90% of bars are produced within the country.

3.4.6 Price Trends

(1) Domestic products

Price trends in steel materials are as follows:

(Unit: US$/ton)

	1982	1983	1984	1985	1986	1987	1988	1989
Steel plates and sheets (1/8")	535	487	553	663	538	555	585	770
Steel sections	627	610	659	716	581	599	594	905
Steel bars (5/8")	669	541	615	714	578	577	572	634
Wire rods (1/4")	674	553	597	682	554	571	571	633
Brilliant steel wires (BWG 9)	742	632	701	813	680	701	646	703

Note: 1) The above prices are ex-factory prices and do not include taxes.

2) Price discount (APDR)

a) For advance payment, the following price discounts are provided:

6 - 25 tons:	3%
26 - 49 tons:	4%
Not less than 50 tons:	5%

b) For quantity purchase, the following price discounts are applied:

50 - 99 tons:	1%
100 - 149 tons:	2%
150 - 299 tons:	3%
300 - 499 tons:	4%
500 - 599 tons:	5%
600 - 799 tons:	6%
800 - 999 tons:	7%
1,000 - 1,999 tons:	8%
Not less than 2,000 tons:	10%

Source: For the 1982 - 1988 period, the current price in pesos as of January of each year listed on the Restructuring Report was converted to the US dollars with the exchange rate of the same month. The 1989 data were taken from the price list of ADPR.

(2) Imported steel materials

Prices of imported steel materials are determined by international market prices and exchange rates. For example, the FOB prices from Japan have been changing as follows:

(Unit: US$/ton)

	1982	1983	1984	1985	1986	1987	1988
Hot rolled sheets	325	293	308	290	288	335	436
Steel sections	259	248	246	237	256	298	401
Round bars	237	231	249	242	251	269	378
Wire rods	319	248	266	251	244	267	313
Steel wires	596	571	603	588	638	722	864

Source: White Paper on External Trade and Commerce

Domestic prices of imported steel materials are determined by adding the following items to the FOB prices:

		Approximately	
1) Ocean freight	:	13%	
Insurance	:	0.5%	
Prior Deposit	:	2.3%	(2% of CIF prices)
Law No.75 charges	:	20.4%	(18% of CIF prices)
Custom duties	:	10%	(For 3mm cold steel plates)
Port charges	:	3%	
Domestic transportation	:	3%	
Handling charges	:	10 to 30%	
Total	:	60 to 80%	

(3) Price comparison

The prices of the locally manufactured products and the import prices (FOB prices from Japan) are compared as follows:
(Price of locally manufactured products/price of imported products)

	1982	1983	1984	1985	1986	1987	1988
Steel plates and sheets	1.65	1.66	1.80	2.29	1.87	1.66	1.34
Steel sections	2.42	2.46	2.68	3.02	2.27	2.01	1.48
Round bars	2.82	2.34	2.47	2.95	2.30	2.14	1.51
Wire rods	2.11	2.23	2.24	2.72	2.27	2.14	1.82
Steel wires	1.24	1.11	1.16	1.38	1.07	0.97	0.74

Generally speaking, the imported products were relatively cheaper than the domestic products except steel wires. Although the difference have been reducing every year.

3.4.7 Quality of Locally Manufactured Steel

(1) Smelting stage

Only ADPR carries out smelting operations by using iron ores produced from their own mines, but these are low in quality and include phosphorus and other foreign matters to prohibit smelting suitable for casting.

(2) Steel making stage

The final products lack uniformity in quality, partly because high percentages of scrap irons are used, and partly because of inadequate constituent control.

(3) Rolling stage

Rolling machines appear to have deteriorated due to aging, not capable of manufacturing the products with sufficient accuracy. In particular, steel plates and sheets are manufactured by Stickle rolling machines which are difficult to attain high accuracy levels.

(4) Availability of related standards

ICONTEC has been developing related standards on the basis of applicable foreign standards, but a wide range of area is still to be covered. So far, internationally applicable standards have been established for various areas, including testing methods, mechanical properties, chemical constituents, dimensions.

3.4.8 Steel Production Related to Metalworking

Most of steel materials used for metalworking, including cold rolled steel plates and sheets, and carbon steel bars, are not manufactured in Colombia. As for these products, price is more of a problem than quality. The pricing issue needs to be considered from the viewpoint of developing the metalworking industry.

As for cast products, foundry pigs are largely imported and present little problem in quality. However, quality of scrap irons varies greatly to result in cast products of relatively low quality. Thus, it is recommended to take effective measures to obtain high-quality scrap irons, including detailed research on sources of scrap irons to be imported.

3.4.9 INACERO (Instituto Nacional de Accro)

INACERO is a non-profit private organization established on the basis of Resolution No.24307 promulgated by the Ministry of Education in 1982, which membership includes steelmakers, distributors, and consumers, totaling 32 members at present. INACERO is responsible for research, training, and information gathering related to the metal and metalworking industries, and for analyzing and proposing solutions for problems related to materials and technological development for the purpose of improving productivity and product quality.

To accomplish these objectives, INACERO conducts following actions to promote substitution of currently imported steel projects by locally manufactured ones:

(1) Research

1) Promotion of steel-related product development programs, including domestic production

2) Promotion of technical development programs at production sections

3) Promotion of quality control programs in areas of materials, production and processing

4) Promotion of programs to boost domestic demand and production capacity for iron and steel, and steel and cast products

(2) Training

Promotion of training programs for specialists, engineers, and workers in the form of seminar and lecture.

(3) Dissemination of information

INACERO owns a library to provide technical information on the metal and metalworking industries and supplies technical and economic information on use,

consumption, domestic production, exports and imports of iron and steel products. Also, it publishes bi-monthly magazine "NOTIACEROS" and occasional special reports to provide useful information for the member companies and production sections.

(4) Technical advice

INACERO provides advice services on selection of iron and steel products, technical standards, international comparison, heat treatment, corrosion, casting, defect analysis, press, quality control, metallurgical and chemical component analyses, and static and dynamic material testing.

(5) Coordination

1) To coordinate government authorities and steel companies on technical issues.

2) To assist the government, universities, and steel companies in promoting development of the steel industry, solving technical problems, and conducting necessary research and development activities.

3.4.10 Restructuring of Steel Industry

The Colombian government is planning to proceed with the liberalization policy as part of the program to modernize the Colombian economy. Below is described the restructuring of the steel industry to face this liberalization policy, citing the summary of a report "Restructuring of the Colombian Steel Industry"

(1) Stages of liberalization

The following three stages of liberalization will be considered.

1) Stage "A": As it is. i.e.
Tariff rates on raw materials: 5-10%
Tariff rates on steel products: 15-25%
Taxes associated with import (law 75): 18%
With import licence system

2) Stage "B": To abolish the prior import licence system and to reduce tariff rates gradually. i.e.
Tariff rates on raw materials: 5-10% (1994), 0% (2000)
Tariff rates on steel products: 15-25% (1994), 0-10% (2000)
Taxes associated with import (law 75): 18%
Without prior import licence system

3) Stage "C": To abolish the import licence system immediately and to reduce tariff rates more quickly. i.e.
Tariff rates on raw materials: 0%
Tariff rates on steel products: 0-10% (1994), 0% (2000)
Taxes associated with import: 0-18%
Without import licence system

(2) Steel demand at each stage

1) At stages "A" and "B":
in 1994, Bars 934 thousand tons
Plates and sheets 375 thousand tons

2) At stage "C":
in 1994, Bars 1041 thousand tons
Plates and sheets 471 thousand tons

If the tariff rate are reduced, prices of iron and steel products go down and a demand on them increases. As a result, industrial growth is expected to be realized.

(3) Cost comparison of domestic and imported products

(Unit: US$/t)

	Present situation		Theoretical situation	
	Domestic	Imported	Domestic	Imported
APDR				
Billets	387	400	384	280
Hot rolled plates	461	560	458	410
Bars	417	475	414	325
Mini steel mills				
Billets	266	400	225	280
Hot rolled plates	318	475	276	325

Notes: 1) APDR denotes Acerias Paz del Rio.
2) Mini steel mills are SIMESA, SIDELPA, SIDEBOYACA, SIDEMUNA and SIDECARIBE.

As shown above, while APDR may lose price competitiveness, the mini steel mills will be able to keep price competitiveness at import liberalization.

(4) Restructuring of steel industry

Facing import liberalization, the Mini steel mills and the surface treatment steel mills (HOLASA, ACESCO and COLPACERO) do not have serious problems and do not require any urgent measures. On the contrary APDR can not cope with international competition without strong protection. Therefore measures to be taken for the restructuring of the steel industry must be focused on APDR. The following are 4 restructuring measures to be considered.

1) Measures for restructuring

a) Alternative 1: To close APDR
This is not conceivable because of the economic and social problems. APDR is the 13th enterprise in the country and has about 5000 employ-

ees. Besides, pig iron APDR only can produce in the country is competitive.

b) Alternative 2: To produce up to billets and to supply them to steel rolling mills.

c) Alternative 3: To produce up to bars competing with the Mini steel mills; and not to produce plates and sheets.

d) Alternative 4: To produce plates and sheets; and not to produce bars.

2) Cost comparison of products between alternatives

The prices of domestic and imported products in alternatives to 4 above at stage C are as follows:

(Unit: US$/t)

	Alternative 2 billets	Alternative 3 bars	Alternative 4 plates
Domestic products	356	380	423
Imported products	280	325	410
Difference	+27%	+17%	+3%

As shown above, only plates have competitiveness at stage C.

3) Advantages for APDR to be specialized to produce plates

a) Utilization of domestic resources
b) Better competitive position than those of other products
c) More added value
d) Satisfactory equilibrium of supply-demand balance of plates and bars in the country
e) Better balance of foreign currency for the country in spite of higher initial investments

These conditions are summarized as below.

	Alter-native 1	Alter-native 2	Alter-native 3	Alter-native 3
Utilization of resources	No	Yes	Yes	Yes
Competitiveness	-	No	No	No
Supply-demand balance*	deficit in plts	deficit in plts	deficit in plts excess in bars	excess in bars
Investments	0	100MUSD	149MUSD	293MUSD
Foreign currency saving	150MUSD	196MUSD	228MUSD or more	290MUSD or more
Social balance	very difficult	difficult	no big problems	good

MUSD: million US dollars

Note: * Based on the condition A and B

(5) Recommendations to the government

1) Trade policy

a) To take the following two measures simultaneously to provide consumers with steel products at low price

- To lower cost of raw materials, in particular, steel scraps imported by the Mini Steel mills, minimizing import duties and abolishing other obstacles such as the prior deposit.

- To abolish the import licence system and to diminish tariff protection to stimulate international competition of steel products. Taking into account the competitive situation, the abolishment of tariff protection on steel bars is feasible in 1994, while that of steel plates would be limited to import

duties. (with residual protection of the taxes associated with import)

b) To establish an "anti-dumping" system.

2) Price policy

Now price control system does not exist and it is not necessary to introduce it.

3) Improvement of infrastructure

a) Elimination of reserve of Colombian ships
b) Reorganization of Colpuertos and suppression of monopoly
c) Optimization of the electric power sector
d) Reorganization of railroad and of navigation on the river Magdalena

The impacts the above improvements of infrastructures give to Mini steel mills are as follows:

	present situation	improved situation	impact to production cost
Elimination of reserve of Colombian ships (Brazil-Colombia)	20US$/t	10US$/t	318 to 312US$/t
Reorganization of Colpuertos	10US$/t or more	5US$/t	318 to 315US$/t
Electricity sector	0.05US$/kWh	0.04US$/kWh	318 to 311US$/t
Reorganization of Railroad and river	10US$/t or more	5US$/t	318 to 315US$/t
			318 to 298 USD/t in total (6%)

4) Support to APDR for efforts to be done by APDR itself to reduce cost

The program of cost reduction in APDR means a reduction of more than 1,000 employees for which the government must support APDR.

5) Financial support to the investments APDR requires

(6) Recommendations to the Enterprises

1) A new examination of the projects contemplated in Colombia

a) Most of the projects contemplated are feasible but it takes more time to realize than considered except the cold rolled mill project sponsored by HOLASA. This project must be proceeded with coordination with steel plate production in APDR.

b) The bar rolling mill for ADPR does not seem to be a feasible investment because APDR must be specialized in plate production.

c) The continuous casting equipment for billet must be replaced with that for slab.

d) The blast furnace projects to use imported minerals (direct reduction or mini blast furnace +"Energy Optimizing Furnace") needs to be postponed.

2) The investment program needs to be well coordinated.

The following investment programs of steel mills need to be coordinated.

a) APDR

- New convertor and continuous casting equipment
- Hot rolled plate mill
- Cost reduction program
- Training of technicians engaged in plate production

b) APDR or other steel mills

- Plant relating to the hot rolled steel mill

c) Mini steel mills

- Introduction of advanced techniques, and economic and financial integration where possible

3) The steel mills should proceed with other programs to assure long-term competitiveness.

a) Agreements under consideration with Brazil or Venezuera may limit competence of these producers. The following should be added.

- Supply of products not produced in the country to the Colombian market.
- Purchase of prereduced minerals at appropriate prices in relation to steel scraps in the international market.

b) Organizational reform

- Clear separation of activities in APDR among mining, steel mill and cement production.
- Higher economic integration of the Mini steel mills, i.e.

  * To diminish the cost of raw materials.
  * To reduce general expenditures.
  * To reduce sales expenditures.

* To perform the second rolling on a communal basis.

4) Improvement of access to technical information

A system to monitor technological development needs to be established, for instance, by FEDEMET-AL to follow the innovation in the world for this sector.

Source: Reestructuracion del sector Siderurgico Colombiano

Resumen Ejecutivo October, 1989

3.5 Distribution System Related to the Metalworking Industry

In Colombia, raw materials, parts and components, semifinished and finished products related to the metalworking industry are distributed through a relatively simple channel which contains a small number of intermediaries between manufacturers and end users.
Metalworking products locally available, including steel materials for construction work, and those imported in whole amounts, such as steel materials and parts and components for agricultural machinery, are primarily marketed by a limited number of large dealers or distributors. It should be noted that the simple distribution system is established not by government efforts, but by market environment where enterprises of relatively small sizes can have direct supply from manufacturers by purchasing minimum amounts. In fact, small manufacturers usually form a union (cooperative procurement organization) to purchase raw materials at economical costs.

Nevertheless, these unions are not operated as a trade organization like COPIME to represent the interests of the enterprises in a certain industry. Rather they are loosely organized cooperatives to procure high quality and cheap raw materials.
An example of volume discount is seen in a wholesale price list of SIDELPA (SIDERURGICA DEL PACIFICO S.A.) in 1988. Prices of stainless steel 302/304 are 2,022,020 pesos/ton for a lot of 1 to 20 tons, 1,733,160 pesos/ton for a lot over 20 tons, and 1,444,300 pesos/ton for a lot over 1,200 tons. When the price for the 1 to 20-ton lot is denoted as 100, that for the over 20-ton lot is 85.7, and that for the over 1,200-ton lot is 71.4; or a 28.6% discount.

The same applies to transportation costs. Colombia does not have a sufficient inter-city railway network as major cities are scattered throughout valleys of in the Andes, and trucks are the most popular means of in-land freight transport. Trucking companies offer freight rates which are favorable for volume transport; while the average transportation cost for a medium-sized truck of 9 tons is 24.55 pesos/ton/km, that for a 17-ton large truck is 20 pesos/ton/km, and that for a 30-ton trailer is 17.48 pesos/ton/km. (As of the end of 1989; from statistics prepared

by the Federation of Freight Carriers of Colombia)

Following sections describe present distribution of major metalworking-related products, namely steel products, automobiles and automotive parts and components, construction equipment and farm machinery, and tools and other small metalworking products.

3.5.1 Distribution of Steel Products

(1) Steel bars and materials for construction work

Steel bars and materials for construction work are fully supplied from local sources and imported in special cases. As seen in Figure 3.21, steel materials for construction work are marketed through two channels; the integrated steel plant in PAZ DEL RIO and its major dealer, COFERSA; and electrical furnace makers of SIDEBOYACA, SIDEMUNA, SIDELPA, SIDECARIBE, HELISCERO, and SIMESA, and their exclusive dealer, DIACO.

When the purchase price of DIACO, COFFESA and other dealers is denoted as 100, prices for SMEs range between 110 and 120, while those of MEs are around 130 since they need to purchase the products through retailers because of small lot purchase.

Payment terms are generally prepayment, letter of credit (30 to 60 days) or cash-on-delivery. The retailers offer credit sales (with sight of 30 to 45 days) to regular customers. Usually 60% to 70% of retail sales are credited, while the remaining sales are made in cash. As a result, MEs who do not have credit with retailers are required to obtain purchase funds from informal lenders. Although it is difficult to collect information on informal lenders, the interview survey revealed that major financial sources for many MEs were relatives, friends, and family members, with an average interest rate of 5% per month.

COPIME purchases raw materials collectively as part of its activities and sells them to its members on credit. The system allows the member enterprises to purchase raw materials at favorable costs and to avoid the use of informal financial sources. In addition, FUNDACION CARVAJAL and FUNDACION SARMIENTO PALAU are providing MEs in their local areas with a collective purchase and credit sales service, similar to that of COPIME, as part of their community vitalization programmes.

(2) Steel Materials for General Use

Distribution of steel materials for general use differs from that of steel bars and materials for construction work in that imported products are available and 10 major distributors control the market. On the other hand, price trends and payment terms are similar. The major distributors tie up with consulting engineers and are capable of checking product specifications.

While there are a few steel material makers for general use in PAZ DEL RIO and other areas, imported products are widely used because of problems in supply capability and quality of domestic products. As a result, the major distributors (also serving as importers) are controlling the market. These distributors are company groups having financial and marketing capabilities but do not have exclusive distributorship. Thus, users with own financial source import the products by themselves. Prices of steel materials imported by the 10 distributors are FOB + 100%, which include a profit margin, insurance premium, ocean fright, custom duties, and custom clearance charges. In addition, unfavorable prices are offered to MEs, as seen in steel bars and materials for construction work. (See Figure 3.22)

3.5.2 Distribution of Automobiles and Automotive Parts and Components

Three major assembly enterprises, CCA, SOFASA, and COLMOTORES, manufacture, Matzda, Renault, and GM models. In addition, there are small assembly enterprises which manufacture their own trucks, buses, and special vehicles without technical cooperation with foreign makers.

The major assembly enterprises import parts and components for CKD from overseas and procure some from domestic suppliers. Parts and components procured by them are divided into genuine parts and components which are used for assembly of new cars and repairing, and copied parts and components manufactured by the suppliers for servicing after sales. When the genuine parts are defined as those supplied by factories in cooperation with the major assembly makers[1/] and those supplied by certified factories [/2] (including parts and components for CKD supplied from overseas), there is a clear difference in distribution channel between the genuine and non-genuine parts. (See Figure 3.23)

Note: 1/ - Denoting factories supplying parts and components on the basis of long-term contract
2/ - Denoting factories certified by the assembly companies in terms of quality

Parts and components manufactured at the suppliers' factories and certified factories are sold only at sales agents or special agents.

While automobile users tend to use the genuine parts and components while their cars are relatively new, but increasingly use the copied ones for older models. Based on information obtained from INACERO (INSTITUTO NACIONAL DEL ACERO) during the visit survey, the market for automotive parts and components for servicing is estimated at approximately US$800 million, of which genuine parts account for 40% to 50%. Note that these are preliminary data as INACERO is in the middle of market study.

On the other hand, the smaller assembly enterprises have much wider sources of parts supply. They generally procure some parts including chassis from the major assembly enterprises, while importing engines, axles, suspensions, steering, and other functional parts and components, and using the copied products for other parts, and carry out installation, interior finishing, and painting at their own shops.

Distribution of complete automobiles takes different routes between the major assembly enterprises and smaller ones. The major assembly makers sell complete automobiles through agents and have maintenance shops within the agents or contract maintenance shops for close after-sales service. Thus major assembly enterprises operate marketing channels which are hierarchically organized. On the other hand, the small assembly enterprises, lacking financial and human resources to establish marketing and service networks, sell complete automobiles directly to users or to car dealers other than special agents of the major assembly enterprises. Obviously, their marketing system is much weaker than that of the major assembly enterprises which includes the dealer help program. There are approximately 10,000 car dealers, including used car dealers, throughout the country, which do not have distributorship agreement with the major assembly enterprises.

3.5.3 Distribution of Agricultural Machinery and Construction Equipment

Agricultural machinery and construction equipment, excepting some spare parts and implements, are not manufactured locally. Also there is no assembly plant under joint venture with foreign makers, unlike the automobile industry, because domestic markets for these machinery are too small to keep domestic production unfeasible, as discussed in detail in Section 2 of Chapter 3. Because of higher unit prices than passenger automobiles, there are not many dealers of agricultural machinery and construction equipment. For instance, agricultural machinery is mainly imported through the 3 major importers and dealers. Being

not locally manufactured, agricultural machinery is classified as a free import item.

Agricultural machinery and construction equipment imported through dealers are initially priced at FOB + 100% and are supplied to end users through one more intermediary. (the secondary wholesaler) For end users without sufficient financial source, the purchase through the secondary wholesaler can be made on credit. In contrast, end users having financial source and proper channel make the purchase directly from an imported/primary wholesaler or from an overseas source. (See Figure 3.24)

3.5.4 Distribution of Tools and Other Small Metalworking Products (Including Household Appliances and Furniture)

These are marketed through the most complicated distribution channel, among other metalworking products. For instance, steel bars supplied from a steel mill are forged to bolts and nuts, which are then incorporated into tools and other products. (See Figure 3.25)

Foreign companies and foreign-affiliated joint ventures assemble these products by using parts and components supplied under CKD or produced in-house or by certified factories, followed by sales through special agents (organized marketing channel). They are usually large enterprises and have a different distribution system from that of domestic companies which are mainly SMEs and MEs.

These characteristics including production and marketing systems are similar to those observed in the automobile industry which consists of foreign-affiliated assembly enterprises and other small enterprises. The most complicated distribution channel is particularly true in the domestic enterprises. The entire manufacturing and distribution processes from procurement of raw materials to manufacture of finished products are divided into the following three processes; (1) production of bolts, nuts, screw threads and other machine elements by processing steel bars and plates supplied from steel mills, (2)

procurement of these primarily processed products for incorporation into own components, and (3) procurement of parts and components for incorporation into final products.

One of major characteristics in these processes is that there is not much subcontracting relationship between manufacturers at different stages, most of whom are independent from each other. As suppliers, semi-finished product manufacturers, and assembly manufacturers operate independently, products manufactured at each stage are distributed to different market segments, such as after-sales and enter user markets.

Relationship between distribution and financial service reflects company sizes and financial positions. SMEs which are generally in good financial conditions purchase raw materials and parts directly from manufacturers to obtain the volume discount. On the other hand, MEs with constant shortage of funds use retailers or agents who offer small lot sales.
As retailers offer credit sales to regular customers, MEs receiving order bookings at a stable rate can benefit therefrom. On the other hand, MEs and Sml-Es which cannot afford volume purchase often resort to collective purchasing by forming unions. Details of such unions are described in 3.5.5.

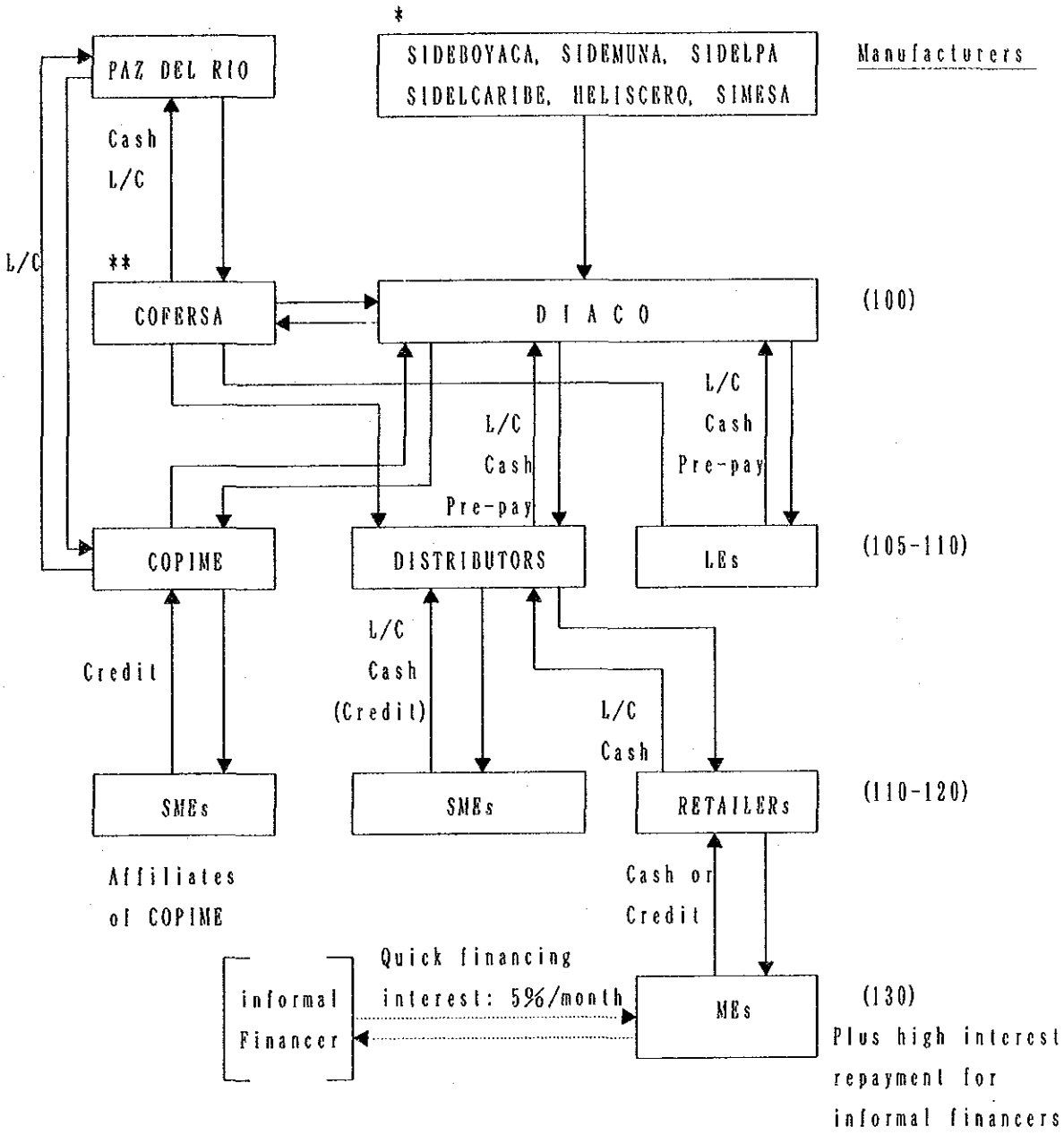
A major problem facing domestic household appliance manufacturers is wide distribution of smuggled products. For instance, distribution of smuggled TV sets and stereo equipment is said to be more or less the same level as domestic production of these products. Prices of locally produced household appliances are 30% higher than imported ones, as the domestic makers emphasize the improvement of after-sales service through organized marketing channels.

3.5.5 Need for Cooperative Purchasing by Small Scale Enterprises and Microenterprises

Many small enterprises participate in unions for collective procurement of raw materials. For instance, a small enterprise to manufacture bolts and nuts forms a union with other enterprises of same trade, through which steel bars are collectively purchased from electrical furnace maker, SIDELPA. In this case, a maker with the largest consumption take delivery of the products and sell them to other members on credit. It should be noted that these unions are not legal corporations like COPIME but are loosely organized cooperatives under verbal agreement between members. As MEs and Sml-Es cannot purchase the minimum quantity set for the volume discount individually, they cannot compete with Med-Es and LEs in production of similar products unless such cooperate efforts are made.

At the marketing end, MEs and Sml-Es manufacturing metal-working products sometimes establish sales outlets, which sell not only own products but products of other manufacturers to customers. This arrangement is advantageous for the improvement of customer service as well as expansion of markets (customer bases). (See Figure 3.26)
Although it is considered to be one type of voluntary chain, it does not include cooperation in staff training, product development and management.

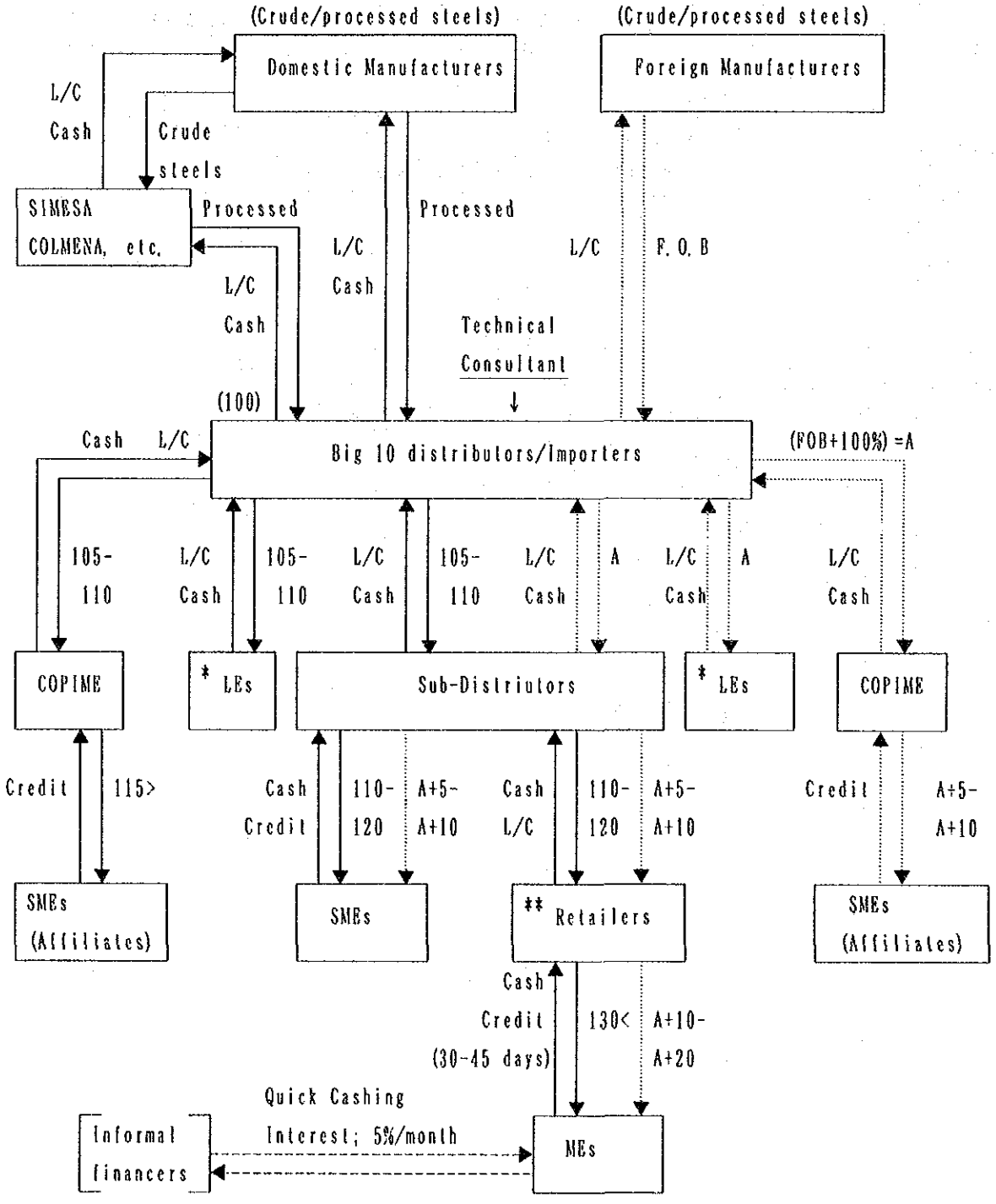
Figure 3.21 DISTRIBUTION OF STEEL BARS AND MATERIALS FOR CONSTRUCTION WORK



* SIDEBOYACA, SIDEMUNA, SIDELPA, SIDELCARIBE, HELISCERO, SIMESA are the share holder of DIACO. DIACO is the exclusive distributor of these manufacturers.

** COFERSA is one of the main distributor of PAZ DEL RIO but has no exclussive relations.

Figure 3.22 DISTRIBUTION OF STEEL PRODUCTS FOR GENERAL USE

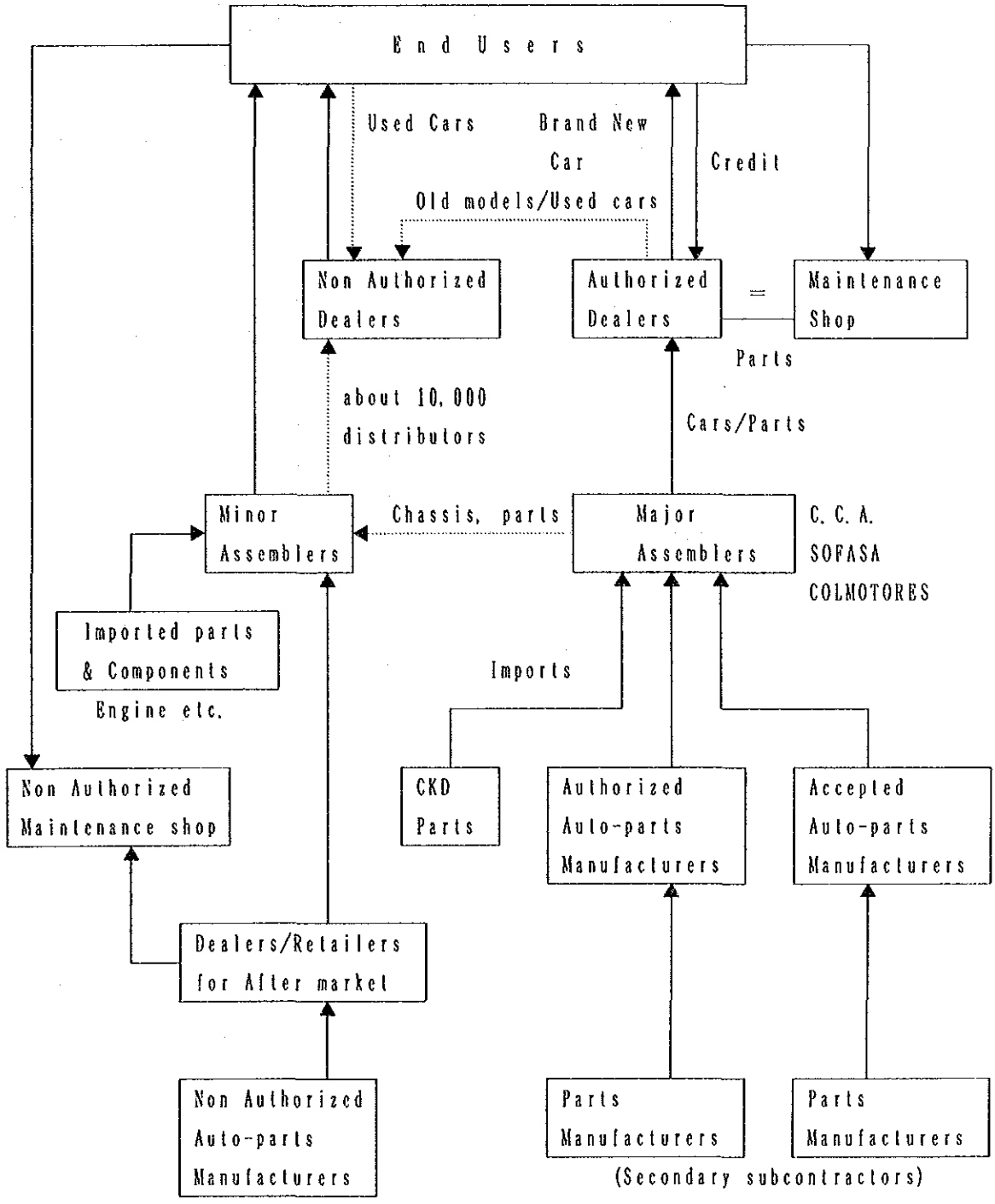


Notes: 1. Big 10 distributors/importers;

- ACEROS INDUSTRIALES
- COMPANIA GENERAL DE ACEROS
- DAESA
- REIDIN
- ALFREDO STECKER
- MANUEL PIEDRAHITA
- CENTRO ACEROS
- BRONZ METAL
- JARAMILLO OBONDANO
- DIMETALES

2. FOB + 100 % = A
3. * ; LEs or SMEs who have stable finance sources
4. ** ; 60-70 % of their sales are made by credit

Figure 3.23 DISTRIBUTION OF AUTOMOBILES AND AUTOMOTIVE PARTS AND COMPONENTS



Notes: 1) 'Authorized' represents the manufacturers subcontracted with the major car assemblers in long term contract.

2) 'Accepted' represents the manufacturers approved by the major car assemblers that their products are acceptable in terms of quality.

Figure 3.24 DISTRIBUTION OF AGRICULTURAL MACHINERY AND CONSTRUCTION

(Imports only)

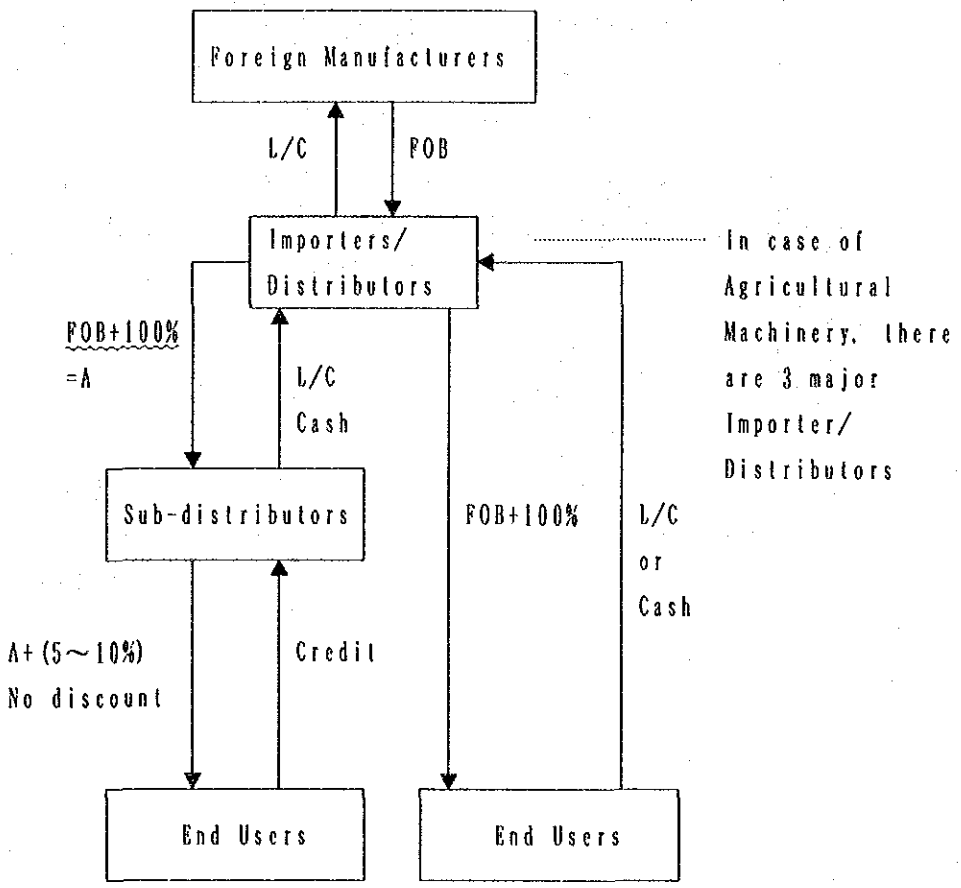
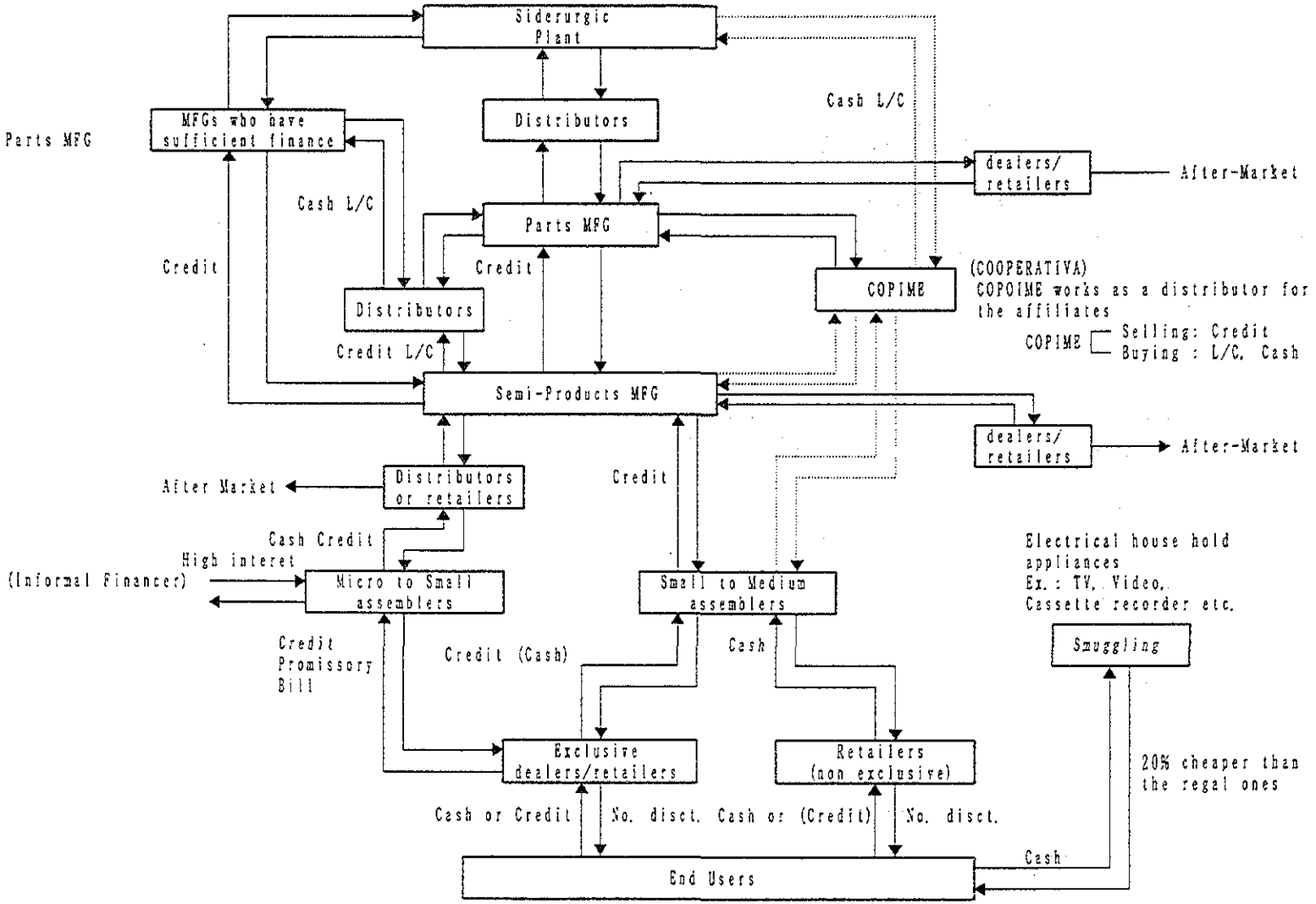
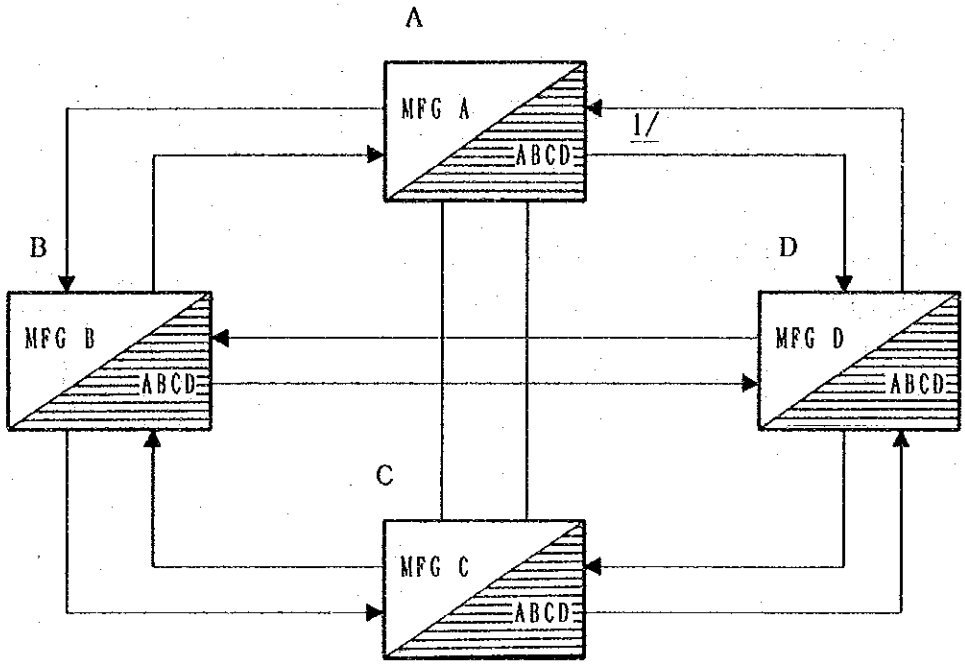


Figure 3.25 DISTRIBUTION OF TOOLS AND OTHER SMALL METALWORKING PRODUCTS (INCLUDING HOUSEHOLD APPLIENCES AND FURNITURE)



1) Most of the case, forging, casting, plating, welding and etc. are done by each factories.
2) COPIME receives 10-20% of discount when buying, and will give their affiliates half a discount. They supply materials (raw materials, parts, semi-products) by credit. COPIME will be able to return their benefits according to the amount of affiliates, deposit.

Figure 3.26 COOPERATIVE PURCHASING BY SMALL SCALE ENTERPRISES AND MICROENTERPRISES



Note: Retailer shop and Handling items

MFG A, B, C, D: Name of Manufacturer

1/: Selling on consigment basis or cross trading