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CAPITAL GOODS PROGRAMME IN MEXICO

CONCEPTION, CONTENT AND ACHIEVEMENT*

by

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I N D E X

Introduction:-

The central object of this report will be an exposition of the conception, content and advances achieved in the NAFINSA/UNIDO Joint Capital Goods Program in Mexico.

The activities carried out in developing this program are indissolubly linked to the specific conditions prevailing in Mexico, the fact that the national institution in charge of the program is an Industrial Development Bank, and the orientation outlined by the government in the Industrial Plan, which establishes the high priority placed on the development of the capital goods sector.

The methodology used for this program was developed in response to specific conditions in Mexico; this point is emphasized as a frame of reference for the considerations presented in the following section: However, it is possible that the experience gained in this project may be useful for other countries wishing to expand their capital goods sector and it is precisely in that spirit that the body of work presented in this seminar by the NAFINSA-UNIDO program has been prepared. Apart from the overall outline presented in this document, the other papers eleborated by UNIDO experts covered the following fields:

Demand forecasting for capital goods, Capital goods supply*, Manufacture of heavy equipment *; Development of the machine tools industry *; Elaboration and promotion of capital goods projects.**

This report is divided into 5 parts. The first part presents a schematic view of the role that the capital goods sector has played in the industrialization of advanced countries; the second contains an identification of some of the factors which explain the sector's lag in the industrialization of Latin America and Mexico; in the third, an analysis is made of the specific features found in this sector in relation to other industrial branches: features which must be taken into account in order to adequately design a development program for the sector; the fourth section describes the different phases of the project; and the fifth section concentrates attention on current activities related to the promotion and negotiation of the projects that have thus far been prepared. This last phase represents the culmination of work directed toward achieving the central objective of the project, in that it will result in the expansion of productive capacity through the shaping of a group of inter-related enterprises which will form a central nucleus for the production of capital goods in Mexico.

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I. The role of the capital goods industry in the development of advanced economies.

The development of the capital goods industry has played an enormously important part in the industrialization of advanced capitalist and socialist economies. In fact, it has been shown that the dynamism of this sector is significantly greater than that of industrial activities in general. 1/ This is partly due to an apparently structural tendency for investment to grow at a faster rate than overall economic activity 2/, and, in part, to the fact that within investment itself, the capital goods component grows faster than total investment. 3/ These two trends are linked with both the rapid growth and the intensity of technological innovation experienced by the economies of advanced countries in recent decades. This same dynamism has simultaneously allowed a greatly enhanced growth of productivity and employment. In fact, it has been demostrated that in the capital goods sector, both productivity and employment have a higher rate of growth than that of overall industrial activity in those countries. 4/ Moreover, this stimulating effect on employment has the added advantage of involving skilled labour; thus the development of capital goods has become an important source of training and specialization of labour whose benefits are eventually spread throughout industrial activity as a whole.

The process of technological innovation in the capital goods industry has not only been a source of increased productivity in the sector

and greater incorporation of innovations in capital goods themselves, but has also played an important part in increased productivity in the rest of the user sectors. The orientation of the resulting technical progress has unquestionably been a product of the conditions under which such a process has taken place. 5/ There is ample evidence indicating that the path taken by technical progress in advanced countries has been associated with a growing scarcity of labour and the its increasing relative cost. The latter consideration applies particularly to the advanced capitalist economies where, since the sixties, wages have been rising at a much greater rate than productivity. 6/ Another important factor has been the relative scarcity of raw materials and, hence, the imperative need for stimulating innovations in the field of synthetic materials. 7/ The capital goods industry has had to adapt itself to the development of new synthetic products, both in terms of the new requirements in materials and in the search for feasible new manufacturing processes and diversification of the uses for existing products.

This process of technological innovation based on labour scarcity and high cost, shortage of natural resources and, in some cases, limited space, has been further stimulated up to 1973 by the use of cheap energy. That is to say, the content and the orientation of the technical progress incorporated into capital goods has corresponded not only to factors within the industrialization process but also to external conditions that have had a decisive influence on that process.

Finally, it must be mentioned that in the international trade of advanced countries, especially capitalist countries, the capital goods industry functions as a payment mechanism for financing the acquisition of natural resources. It can be noted that the surplus generated by capital goods in these countries roughly corresponds to the deficit they sustain in the purchase of natural resources. 8/ In other words, the technological advances involved in capital goods production capacity have become a decisive factor in neutralizing the lack of local natural resources. Obviously, these generali zations about the developed countries tend to neglect the heterogeneous nature of the group, and after the second world war there was an important relative change in the international trade of capital goods within developed countries which could be characterized by a trend toward specialization, on one hand, and a modification of the relative position of the different countries, on the other. 9/

Nevertheless, accepting the general hypothesis that the capital goods industry has a deep involvement with technical progress and that it has played a central role in the industrialization of advanced countries, it becomes necessary to look into its role in Latin American industrial development.

II. - Capital Goods in the industrialization of Latin America

It is evident that the capital goods sector is suffering from a quantitative lag in the larger countries of the Latin American region, 1/ but it should be pointed out that the lag is even more critical in terms of quality; that is, in local capacity for contributing to the basic engineering design of complex equipment and installations. This being the case, some questions must be raised about the factors that have been responsible for the development of this sector during the rapid industrialization of Latin America in recent decades. At the moment it can be seen that certain countries in the region, especially those striving for a more autonomous development and a higher "national" component in their projects, have shown a growing concern for reinforcing the development of the capital goods sector.

The lag in the capital goods industry in Latin America can be traced directly back to the pattern of industrialization followed by the region in the last decades. A central element in industrialization policy was the quantitative stimulation of investment, especially private investment, and to accomplish this it was necessary to create conditions under which investments would have the lowest possible cost. This was achieved to a great extent by encouraging the importation of capital goods. Stimulus was provided for the production of non-durable consumer goods, and later on,

for durable and intermediate goods, but the local production of machinery and equipment, whose initial phase would have raised the cost of investment, was neglected. Empirical evidence shows that the protection level granted to the capital goods industry is significantly lower than that enjoyed by other industrial activites. 11/ To this basic situation other facts must be added having to do with the user industries (i.e. demand) and the potential suppliers of capital goods. First, it is useful to distinguish between users in terms of public enterprises, transnational affiliates and private national enterprises. For public enterprises, the main restriction in purchasing capital goods has been financial. One of the characteristics of decentralized public enterprises in Latin America is that they consistently have a deficit in the capital account; and this has to do with the fact that price policies of such enterprises are designed precisely to subsidize the acquisition of those goods and services provided by these same enterprises. The deficit in capital account is neutralized by access to international financing, which as is well known, is associated with the importation of capital goods. As a result, there is a structural and financial element in the functioning of public enterprises which impedes their dynamic participation in promoting locally produced capital goods. There is a marked difference between this situation and the role that public enterprises have played in the development of the capital goods industry in developed countries. There, a close collaboration between public enterprises and national producers has been stimulated in both commerce and tecnology, at times in response to questions of national interest. This has been the case in the

energy , communications, transport and armament sectors, among others. As a result, a good part of the development of these industries has revolved around the central role played by this close connection between public enterprise demand and the larger national private firms of those countries.

The affiliates of trasnational enterprises have a policy for the purchase of machinery and equipment that is part of the global policy of the enterprise at the international level. In some cases the equipment and machines they use have been specially designed for those enterprises and are patented by the user firm. This is seen more frequently in the case of the automotive, food and pharmaceutical sectors.

Moreover, the importation of capital goods is the form in which direct investment to the country is expressed - not in the form of liquid financial resources but rather embodied in machinery and equipment. Also, the division of work established by the affiliates' policies means that for some products in the final phase of the "product cycle" certain production activities are transferred and, along with them, there is a transference of the necessary equipment and machinery from installations in developed countries to affiliates in developing countries. Due to these circumstances, even though the demand for capital goods corresponding to the transnational affiliates is a substantial portion of total demand, it does not really represent much support for local production.

Finally, in the case of private national enterprises, which are mostly medium and small-sized firms, the problem of the financing conditions offered in the purchase of capital goods is a decisive factor and the conditions offered by local producers are notably less attractive than those found on the international market.

In considering capital goods suppliers, a differentiation must also be made between national and foreign producers. Originally, foreign producers had an open market for exporting goods from their country of origin. As long as this option was open their motivation for coming to developing countries to install local production centers was very low due to the lack of technical infraestructure and the idea that local markets were small and fractionized among large numbers of international producers.

Later, however, certain markets began to close because of rising protection levels or, in some cases, because some of the enterprises belonging to oligopolical structures in different subsectors of industry began to take advantage of their maintenance and repair installations to install local production units. The characteristic imitative behaviour of markets began to unfold and the rest of the members of the oligopolical structures sought to establish themselves locally, but without causing any substantial alteration of the stable export currents. This was accomplished by restricting their local production to the simplest sizes and kinds of equipment and by keeping the degree of local integration relatively low. For the foreign producer, the option

of local production only became interesting at the moment in which there was a risk of losing the market.

For national producers, the capital goods sector was just one of many investment opportunities and, for reasons mentioned above, was considered as a somewhat less attractive option from the point of view of profitability and its greater exposure to international competition where buyers were technically more demanding and more inclined (because of structural factors mentioned before) to satisfy their demand abroad. These considerations along with the apparently greater technological complexity of the capital goods sector, tended to turn national private capital toward other sectors, making capital goods production a relatively marginal component of enterprises whose main activities were concerned with other industries.[12/]

The pattern of industrialization and the structural and institutional factors that have been mentioned tended to channel potential demand toward foreign sources and to discourage potential suppliers of local production. Together they make up the main factors explaining the weak development of the capital goods sector in Latin America. Thus, it must be concluded that the development of the capital goods industry, far from being a simple matter that can be solved by merely dictating legal dispositions and specific policies, implies the need to introduce important modifications in the pattern of industrialization of the region's countries.

In keeping with the hypothesis that technological development is to a great extent incorporated into the capital goods industry, it can be assumed that the weakness observed in the technological sphere in Latin American is associated with the lag in the capital goods sector. In addition, it becomes evident that to overcome this problem ut will not be enough to simply create specific norms directed toward stimulating research and development activities at the enterprise level and to regulate foreign technology transfer, as long as all of the factors making up the "industrialization style" of Latin American countries remain unchanged. The solution to this problem is a challenge that must be faced if the capital goods sector is to be developed and the technology of the region is to be reinforced. It is not just a question of developing an industry that might have fallen behind because of technical neglect but rather of introducing well planned, coordinated modifications in an industrialization pattern which up to now has tended to reject the expansion of this sector.

III.- The specific nature of the Capital Goods Project

The capital goods sector has certain specific characteristics that not only distinguish it from other industrial sectors, but make it essential that the content of a Development Program aimed at contributing to efficient production expansion, go beyond the simple listing of independent projects. This report will give an indication of what some of those specific characteristics are and how they form the basis for the sequence and content of the capital goods development program.

1. Capital goods demand: discontinuities and desaggregation

Capital goods requirements are determined by the expansion of productive capacity in different sectors, including the capital goods sector itself. [13/] *Since the time periods needed for the establishment of industrial plants and the construction of equipment are relatively long, it is necessary to have access to long and medium range views as to the expansion of economic activity in terms of individual sectors. In the case of large, high unit value equipment, whose size and technical characteristics often define the industrial plants in which they*

are used (electricity generators and turbines, turbocompressors, boilers, blast furnaces) it is essential to have a knowledge of not only the aggregate investment figures for the respective sectors (electrical, petroleum, steel sectors) but also the principal parameters of the most important projects to be undertaken by those user sectors. In the case of such large equipment destined for specific uses, demand forecasts must be carried out in close coordination with the organizations responsible for the development of the user sectors; only in this way can the necessary technical cooperation be achieved and a sequence of periodic evaluation be carried out regarding the effect that the frequent modifications in the investment programs of user sectors will have on the capital goods sector.

Due to the magnitude of individual projects in the discontinuities generated, the characteristics of investments in highly capital-intensive user sectors (such as electrical energy generation, transport, and distribution of petroleum, petrochemicals, steel mining and cement), place definite limitations on the possibility of using the traditional forecasting system used in other sectors (i.e. that of extrapolating and projecting past tendencies) and make it necessary to arrive at a specific knowledge of the large user projects.

In order to produce heavy equipment it is necessary to have installations that can carry out the basic processes of casting,

forging, platework, machining and heat treatment to estimate the demand for these activities it is necessary to know not only the number and technical characteristics of principle units(turbines, generators, off-highway trucks, earth moving equipment, large diesel engines, and blast furnaces) but also the major parts involved in such equipment which will require casting, forging and machining operations. Thus, the development of a heavy machinery and equipment industry, for which the infrastructure projects mentioned previously are a necessary condition, requires a knowledge of the investment programs of the major strategic sectors in the economy, the specific projects that make up such investment programs, the main equipment involved in those projects and the components, materials and manufacturing processes that enter into the production of each kind of equipment. To illustrate the magnitude and nature of the information needed to define the demand for basic infrastructure processes, Table 1 has been presented, which outlines the demand estimates for a casting, forging and heavy machining plant requiring an investment of approximately 240 million dollars which is in the process of negotiation between Nafinsa and a foreign company.

In the case of multi-use equipment used in a wide range of industrial plants, (motors, pumps, valves) which are produced in standard sizes within a certain range, the technical differences in

users projects are less relevant and coefficients based on historical tendencies, and global future projections may be used to provide relatively satisfactory figures for estimating future demand. Nevertheless, the information needed for indentifying demand in terms of families of equipment having similar technical characteristics, and range within the technical parameters, becomes particularly important in defining the relation between new projects and existing plants. In fact, if the expansion of productive capacity is to be suitably integrated with and reinforce existing plants, it is essential that the decisions regarding increases in capacity in the aforementioned areas (extended production lines in the same plants or in new plants, and diversification toward new products) be supported by a relatively desaggregated knowledge of requirements in terms of families and ranges of present capacities and of the possibilities of interrelating both. It is also evident that these projects can be defined without such knowledge, but in that case there would be a tendency to consolidate and intensify production fractionization in inefficient plants whose chances for competing on an international scale would be reduced to a purely rhetorical level.

If the production of capital goods were carried out in industrial plants defined along the lines of single products and manufacturing processes, using technologies that had reached a high level of

maturity and stability, the specific character of the capital goods sector would be limited to the aspects that have been thus far indicated. In the following paragraphs, consideration will be given to the aspects pertaining to the multiproductive, multiprocess, technologically dynamic character of the design, manufacture and, in some sectors, utilization of capital goods.

2. *Capital goods supply: multiproducts and multiprocesses.*

Having identified specific investment projects, it is necessary to go on to a definition of the kind of productive structure that will generate such lines of production.

This stage is particularly important in the case of capital goods whose production involves various different technical processes; in some cases the processes may all be located in the same plant, and in others there may be a horizontal structure in which certain technical processes are utilized for the manufacture of different kinds of equipment whose final assembly is carried out in independent plants. Although this aspect is often left out of the literature on technology transfer, in practice it is a decisive factor in terms of the effects of and potential for technological dynamism in the plant being considered. In fact, one of the

peculiarities of this sector is the fact that, for some kinds of capital goods, plants have a certain degree of flexibility for producing different kinds of equipment. There is not a specific relationship bewtween plant and product. Moreover, the manufacture of some kinds of heavy equipment requires different manufacturing processes which may or may not be vertically integrated in one plant. [14/] *As a result, the options chosen for the formation of the productive structure, both in terms of the variety of products to be produced in the plant and the degree of vertical and horizontal integration of the productive structure, seem to constitute a decisive factor in capacity for innovation at the plant level. From the point of view of foreign firms who export to the national market and have been induced to establish production within the country, the most suitable kind of arrangement is that which provides a maximum of autonomy from local production activities and permits close ties with plants established in the country of origin. This normally leads them to design vertically integrated plants which, at the same time, have a low degree of national integration; that is, part of the components used in the production of equipment would be imported and those manufactured locally would have to be produced in installations set up within their own plant. In developed countries, an increasingly accentuated trend is toward specialization*

and "horizontalization"; in other words, firms seek to reach a level of excellence in given kinds of machines whose main technological contribution lies in their design; but for production purposes they prefer to use a horizontal structure, acquiring parts and components from the local or national plants that manufacture such goods in the most technically adequate way. From the point of view of government policy, there are two clearly differentiated options: to stimulate the kind of plant concept that corresponds to the preferences of foreign investors, who are the technology suppliers and whose proliferation usually results in supply fractionization and low national content. This option represents the "path of least resistence", conforming to the will of the foreign supplier. The other option is one which seeks to shape a productive structure that is adequate for the internal expansion of capital goods manufacturing but at the same time attempts to raise efficiency through horizontalization of production. The technological element of each of these options can be a decisive factor in the long range results obtained from the development of the capital goods industry. In the specific case of heavy equipment manufacture in México, a systematic comparison of these two alternative conceptsof productive structure was made, including economic factors (investment, employment, foreign exchange) and strictly technological factors.[15/]

It was concluded that the option implying a group of independent plants with higher in-plant integration and lower national integration required less investment than the "horizontalized" and specialized production structure with its lower degree of in-plant integration and higher proportion of national integration. Nevertheless, it was found that the difference in the amount of iwestment could be recovered in two years through savings in imports generated by the possibility of "internal interrelation". Significant technological advantages can also be obtained in terms of potential for developing design capacity, improved efficiency in the utilization of installations and an enhanced degree of specialization in production processes. All of this logically would result in lower costs and a greater capacity for competing on the international level.

3. *The capital goods sector: an agent for transmitting technological progress.*

One of the specific characteristics of this sector is precisely the fact that within the development of the industry an important objective is thestrengthening of the country's reserves of technological data; and this is explicitely expressed in the Industrial Plan. Since the sector is a transmittor of technological progress, its expansion implies a greater probability of participating in the process of technological innovation on an international scale. This is, however, by no means a self-evident implication

in fact, it cannot be assumed that national technological capacity can be strengthened by the development of just any capital goods industry regardless of the conditions of its development. (i.e. which economic agent is responsable, what the manufacturing conditions are and the degree of national par icipation in design) Likewise, not just any methodology used in developing the capital goods industry will automatically result in the achievment of the goal of local technological development. On the other hand, it is quite evident that the absence of the capital goods sector would make it very unlikely that the technological level of the country could be strengthened. In other words, the development of the capital goods industry seems to be a necessary but by no means sufficient condition for the strengthening of national technology. The specific decisions regarding technology, made during the various stages of planning, are the factors that will determine whether or not the final results of the planning process will lead to the desired goal. There is no doubt of the importance of including technological development in the industrial strategy as one of its primary goals. This can provide a necessary (though not sufficient) catalyzing element to stimulate the mobilization of the various levels entering into such development and makes it more possible to move toward the objective. The step of moving beyond theoretical scientific and

technological formulations to actually recognizing the priority of developing of a sector that acts as a transmittor of technical progress, is, in itself, a significant advance.

Within the selected subsectors, there are some lines of production that are in a semi-experimental phase; these will probably show a rapid increase in technological innovation in the future but at the same time are not devoid of certain risks of failure.

There is another group of lines of production that are in a phase of technological refinement with a relatively rapid process of technical innovation in production growth and diversification. These are categories that face intense competition, whose appeal lies precisely in their high degree of dynamism. A third group of products consists of those in which technology has reached a stable and terminal stage in the technological cycle, where the rhythm of innovation has subsided and where international competition has probably increased due to free access to established technologies and excess use of installed capacity. In this category, the risk of future substitution by new products being developed must always be taken into consideration.

The selection of products suitable and desirable for local production becomes a complex process of considering all of the elements described previously, together with technological trends within the different subsectors. [16] *To illustrate, a few paragraphs about trends in the machine tools sector are included.* [17]

-"The latest designs in machine tools are based on the building-block principle. In numerically controlled machines a greater degree of automation is achieved by adding modules, andconversely, machines can be simplified in the same wa and controlled by programs, cams or even left without any control element.

-There is a growing trend toward the use of display units to facilitate manual job control for both automatic and mechanical machines

-There is a growing use of stepping or stepless DC motors in order to realize rapid traverse speeds, short positioning times and high positioning accuracy. Spindle and slide drives are increasingly driven by motors which can be controlled directly by the electrical inputs. This presents possibilities for simplifying or even eliminating gearboxes, clutches, etc.

There is a remarkable increase in rapid traverse speeds. The present level is 10 to 16 m/min. and the trend is to increase up to 20 m/min. to minimize the time for positioning and idle running.

- Numerical control systems will no longer be used only for directing the tools or the relative motion between tools and workpieces but will be used for directing whole sub-systems (e.g. in electronically generated coupling for gear hobbing machines of WMW)

- Soft-ware systems will be simplified more and more, due to advances in micro-processors that will be used increasingly for numerical control systems.

- Machine tools will have two central systems for lubrication and cooling. Improvements in this area will be mainly focussed on thermal control of coolants and hydraulic fluid in order to allow functioning close to the thermal-stable points of the machine tool. Automatic chip removal systems will be incorporated also.

- The manufacture of machine elements, mountable subunits and units, etc. will become more precise so that the time for assembly will drop to about 25 to 30% of total manufacturing

time. This will also be a result of increased use of handling systems, industrial "robots" (often used for dangerous or unhealthy work such as spray painting) and assembly equipment".

These technological trends provide a basic frame of reference which must be kept in mind when it comes to selecting the products most suitable for development, and also for negotiations with technology suppliers.

Most recommendations concerning technology transfer place emphasis on the "conditions" of the transfer and the need for developing countries to avoid restrictive clauses and excessive costs. However it is equally or even more important to consider the "content" or "quality" of the information that is being acquired and this is to a large degree determined by the extent to which the user makes an effort to study and compare his technical requirements and the available technologies on the international level, before entering into negotiations with a specific supplier.

This preliminary act of reflection on the part of the user should be expressed in terms of a definition of the technical nature of the project to be undertaken and will serve, in spite of its preliminary nature, as a guide for negotiations with the foreign

technology supplier. It is often the case in Latin America that negotiations are begun without having invested the time and resources necessary to formulate such a preliminary conception Under such conditions, the technology supplier, interested in consolidating his position and avoiding competition, often takes the lead in proposing the technical conception of the project that will later result in a contract for technology transfer. And it is precisely this phase of technical realization that determines to a large extent the nature of the technological contribution, in terms of design, process and manufacturing engineering, that the project will make to the country. This phase, along with the definition of training programs, will ultimately define the "content and quality" of the technology transfer. [18/]

There is no doubt that the "conditions" under which the transfer is made should not be punitive, but it must be emphasized that no matter how favourable the conditions may be, they cannot offset the defects that might result from an inadequate project definition (e.g. use of unsuitable manufacturing design, process and techniques, over-sizing of certain lateral equipment, inadequate definition of product lines, unfavaurable proportion of in-plant and national integration, absence of supporting technical infrastructure and weakness of training programs.)

In the light of these consideration, it was decided that before entering into any negotiation, a prefeasibility study would be prepared on the basis of information on the design and techniques being used in leading international enterprises, compiled through visits to their respective plants. This does not mean that the most advanced technologies will necessarily be adopted in every case, but at least it provides the possibility of undertaking negotiations with a good knowledge of the available alternatives.

One of the factors determining the possibility for channeling capital goods demand toward national suppliers is the degree of technological development attained by the large user enterprises in the public and private sectors particularly in the fields of basic and detailed engineering. This is especially true in the case of custom-designed capital goods and installations that have complex systems which include several kinds of capital goods. To the extent that the user enterprise delegates the responsability for the technical conception of the projects to either national engineering consultants or to foreign consultants, it is correspondingly probable that local capital goods manufacturers will be limited to acting as sub-contractors for the simplest parts and equipment, leaving the manufacture and technical conception of the more important equipment in the hands of foreign enterprises.

The development of the technological level of the major user enterprises is a decisive factor in the potential development of the national capital goods sector. This has been empirically proven in the case of Mexico, through a study which analyzes the effect that the development of engineering capacity in the Mexican Petroleum Institute (Instituto Mexicano del Petróleo) has had on the situation of national capital goods manufacturers.[19/]

The above considerations tend to confirm that the development of the capital goods industry must be approached on the basis of an integrated program of actions that can influence the complex decision-making system made up of national and foreign producers, public and private users, engineering firms, financial and commercial intermediaries and the whole of the supporting technological infrastructure.

The modification of the internal working of this system, in which technology plays an important role, necessarily implies altering, to some degree, the industrialization pattern which forms the common framework of these economic agents and the relationships through which they are linked.

IV. The Progress of the Capital Goods Program

In 1976 a strategy proposal for the development of the capital goods industry was formulated. [20/] A series of conferences for both public and private sectors was organized and gradually a political climate favourable to a high priority for the program was formed. [21/] The strategy proposal contained an analysis, of the role of the capital goods sector in some Latin America countries, the international framework within which the capital good industry functions, the present and future demand of this sector in Mexico, the economic, technological and financial characteristics of industry and its present market and supply conditions. On the basis of this analysis, subsectors worthy of priority attention were identified, using the following criteria. Size of present and future demand; extent of development of present supply; potential for international competitivity; share of public sector demand; technological importance. Also in view of the high priority status of agriculture and energy within the global development strategy it was considered, desirable to achieve a degree of relative autonomy in the investment process of these sectors which implied giving priority to the manufacture of the capital goods required by them. This set of criteria, some of which were quantifiable and others involving qualitative descriptions and evaluations, resulted in the identification of the following subsectors. Agricultural machinery, equipment for the petroleum and electrical energy sectors and equipment for the steel industry. Widely used equipment such as valves. compressors, and deisel engines, infrastructure goods for use within the capital goods industry itself,

work was begun on a deeper and more detailed analysis of each of the subsectors defined as having priority; estimating the demand for the next ten years,[22] and identifying the production lines which would provide concrete investment opportunities and permit the design of political instruments suitable for particular sectorial needs. At the same time, proposed political instruments began to be put into effect, resulting in the modification of the operating rules of existing financial mechanisms,[23] design and implementation of fiscal incentives,[24] and formulation of norms for channeling part of public sector demand toward local suppliers[25]. In the sphere of protection measures, new criteria were designed to provide protection for existing industry, estimulating an increase in their competitiveness, and to promote the development of new capital goods through selective and gradually diminishing protection. Greater freedom was given to the importation of those capital goods that, within the framework, of the strategy, were not considered to have priority importance during the next few years.[26] In 1978, based on a backlog of information which now included estimated demand figures for the next ten years, knowledge of supply obstacles and identification of investment opportunities, together with a set of instruments for modifying the behaviour of users and potential producers, work was begun on the elaboration of prefeasibility studies for capital goods in the branches that had been defined as having priority.[27]. In 1979 work is continuing on new prefeasibility studies and the systematic promotion of the previously prepared projects has been initiated.[28]

such as machine tools, foundry, forge and thermal treatment and the technologically important subsector of professional electronics, were also identified.

One of the major conclusions of the development strategy proposal was the need for specialization in categories which could shape a productive structure capable of dynamic self-stimulated growth through industrial inter-relations within the capital goods industry.

Another important part of the development strategy was concerned with the political instruments that would be needed to change to behaviour of public and private economic agents which had been reluctant to participate in the development of this sector in the past. It was necessary to influence both the demand sectors, taking into consideration the different behaviour of the public (and private foreign and national) enterprises described previously, and the supply sectors with their particular reasons for lack of interest in entering into capital goods production in the past. Some of the most out-standing elements of this set of instruments were financial support mechanisms for the production and purchase of capital goods, norms for changing the pattern of behaviour of users in the public sector, fiscal incentives needed for stimulating private sector interest in the manufacture and acquisition of locally produced capital goods, instruments designed to reinforce the internationally competitive position of locally produced capital goods and instruments oriented toward promoting research and development both by manufacturers and by users. In 1977

V. Promotional Program

1. Specific criteria.

Since 1978, work has been carried out on prefeasibility studies and promotion of 38 specific projects; this work is expected to be finished during 1980. These projects form an interrelated nucleus which, together with the spontaneous expansion of existing enterprises, could create the conditions necessary for the establishment and functioning of a group of enterprises whose combined activities would create significantchanges in the productive profile of the capital goods industry. It is expected that this will be accomplished within the duration of the present Administration. The new profile will include important increases in production capacity for machinery and equipment that is already manufactured in the country, development of productive capacity in product families similar to those already being produced but in higher ranges of size and technological complexity, and the appearance in Mexico of new products whose manufacture implies significant technological advances in the national industry.

The main criteria for this investment program are the following:

- It is essential that simultaneous progress be made in the expansion of existing capacity, increase in ranges and technological complexity, and development of substantially new production lines.

Expansion in these three directions must be selective and must work toward the rationalization of existing industry, its growing interrelatedness and the smooth incorporation of the new productive capacities.

- Production will, at first, mainly be directed to taking care of internal demand, but the sizing of plants and definition of their technical and economic parameters should allow for the development of a growing participation in the international market. Only in special situations, such as for training purposes or supply security, will support be given for the establishment of plants on a smaller scale than that needed for participation in the international market.

- The public sector will have direct participation principally in projects involving the development of new product lines, including both those which are radically different from existing products and those that involve greater sizes or technical complexity than goods already being produced locally. In regard to the present production lines of established plants, the public sector will tend to provide financial support and only in special cases enter into direct participation.

2. Characterization of specific projects.

The group of projects currently being elaborated by NAFINSA reflect the application of the aforementioned criteria; the most

important objective sought throughout this series of projects is the initiation of heavy machinery and equipment production in Mexico.

It is evident that in order to arrive at this stage, advances must be made in the quality of product and manufacturing engineering and a basic link must be forged between the technological requirements of the users(petroleum, electricity, steel, mining and cement) and the manufacturing technology of the metalworking industry. Since the heavy machinery and equipment to be produced is mainly used in branches where public sector enterprises often play a strategic role, the development of heavy machinery implies bringing together the large public sector firms and the major capital goods manufacturers who normally exercise a kind of technological leadership over the manufacturing industry as a whole. This combination of interrelation and leadership has played a crucial role in the technological development of the capital goods industry in advanced countries. Another important effect will be that of increasing the element of autonomy in the investment process for sectors whose development is considered to be of strategic importance. The principal projects being elaborated and promoted at the present with a view to forming a production nucleus of heavy machinery in Mexico, are the following:

Electricity turbogenerators 150 to 300 MW

Turbocompressors

Large-diameter welded piping (oilducts)

Motor scrapers, cranes and excavators

Front loaders

Crushing and grinding equipment

Large capacity pumps

Cement equipment

Steel equipment

Shears, benders and rollers

Boring machines

Vertical lathes

Radial drills

Grinding machines

The last categories of "heavy machine tools" are capital goods that are used for producting other capital goods and constitute the most important source of training for technical personnel for the metalworking sector.

The production of all of these classes of equipment requires installations equipped for carrying out casting, forging and machining operations on very large, very heavy pieces, as well as the manipulation of heavy plate. Such installations, at present not available in the country, are the concern of infrastructure projects whose main users would be the projects listed above. In this sense it can be seen that the group

of projects make up an integrated whole, formed by independent but technologically interrelated enterprises. In advanced countries production capacity for heavy machinery and equipment has usually developed gradually over many decades through a process in which the equipment producers stimulated the development of basic infrastructure and, in turn, the development of infrastructure provided encouragement for finished product manufacturers; and all within a close working relationship with the user enterprises, whether public or private. The challenge faced by Mexico is that of integrating a system of mutually supporting projects within a very short period of time. Thus, one of the central objectives of this program is to achieve, during the three years left in this six-year Administrative period, the development of a quantitatively significant heavy machinery production capacity that at the same time will be technologically competitive.

For this first group of projects, the strong participation of the public sector will be necessary in promoting and furnishing capital for the new enterprises to be established.

A second important objective of the promotional program is concerned with the need to enhance the technical and industrial interrelations within the capital goods sector, promoting the manufacture of multi-use equipment and components, which are normally mass produced and up until now have been locally produced only in low ranges of size and technical complexity with a low degree of integration. Within this group of projects would be included:

Diesel engines from 1000 to 6000 HP for locomotives and ships.

Diesel engine turbochargers

Crankshafts for engines

Control valves over 2"

Hydraulic oil-pressure pumps

Within this group of projects related to general use inputs and components, there are enterprises already established that produce such products in smaller ranges, and with a low integration level. For this reason, this group of projects would be generally linked to the expansion of existing enterprises, many of which are foreign. The need for direct public sector participation should be analyzed on a case-by-case basis.

The third group of projects involves activities which could be described as "technologically intensive", without necessarily requiring large investments. They are:

Hydraulic pumps for motive and control systems

Digital multimeters, osciloscopes, frequency meters and wave generators

Accessory equipment for computers and terminals

Control and process panel instruments

Gear manufacture

Various families of equipment pertaining to the professional electronics field

Apart from pumps and gears, this group of projects belongs to the field called professional electronics: an industry that will have an increasingly decisive influence on the technological development of the capital goods industry in coming years. The most concrete expression of such influence will be the growing use of microprocessors for the control and regulation of equipment and whole plants. This group of projects initiates, in a modest way, Mexico's entry into a demanding field whose level of internal development can be a determining factor in defining not only the international competitiveness of the capital goods industry but also that of a wide range of other goods.

For this group of projects, the main objective of public sector actions (essentially promotional) should be the stimulation of national groups which have the capacity to enter into the design activities that make up the central pivot of professional electronics development. The actual manufacturing of components requires techniques and a scale of manufacture which, for reasons of volume, may be unsuitable for undertaking in Mexico at this time. Nevertheless, design and assembly activities for components using locally designed circuits is well within the reach of national electronics engineers. The most important work will be to identify and stimulate the formation and development of groups which, apart from having the necessary technical competence, are willing to take on the challenge of initiating activities in this new field.

The last group to be considered is a special category of projects for machinery to be used in the agricultural sector. The importance of these projects is not found so much in its investment volume or technological impact, as in the significance of generating productive capacity for machinery and equipment needed in a strategically essential sector. The experience of other countries indicates that the development of design capacity for machinery and equipment suitable to local agricultural conditions can play a significant part in increasing productivity and the ability to take advantage of the country's natural conditions. It is evident that these projects do not pretend to face the whole agrarian problem of Mexico but, within the scope of capital goods, they can make a contribution to its solution. The specific projects include:

Equipment for the dairy industry

Packing equipment

Refrigeration equipment

The public sector should basically act in a promotional capacity for this group of projects, stimulating established national and foreign enterprises to expand their production. Only under exceptional circumstances would the direct intervention of the public sector in new enterprises be justified.

3. Economic effects of the program.

In order to envision the economic implications of the proposed capital goods program, it is useful to refer to a synoptic view of the role that this sector has played in the advanced countries, such as was presented in the first part of this report. In fact, the technological impact of the capital goods sector goes far beyond the direct impact of investment, employment or import substitutions, no matter how important they may be.

According to information provided by the Industrial Plan, the trade deficit of the capital goods sector in 1970 represented precisely 54% of the deficit in the manufacturing industry; by 1975 this percentage had risen to 56%, reaching 68% by 1978.

It is important to point out that in 1978 the capital goods trade deficit was similar in size to the total trade balance deficit.

When the encouraging prospects of Mexican petroleum supplies are considered, an image could be created of the practical disappearance of foreign trade problems, which would make the development of the capital goods sector seem much less important. The Industrial Plan itself takes care to correct this erroneous idea by emphasizing the high priority given to this sector for reasons linked with technological development. It is increasingly clear that a stable capacity to compete in the international market is, to a large extent, determined by technological advances and personnel training.

In fact, according to the forecasts published in the Industrial Plan, in spite of the high goals fixed for national capital goods production, the capital goods sector's deficit by 1982 would be comparable to the petroleum sector's surplus and would practically double the national trade deficit. By 1990, the capital goods sector deficit would almost triple the surplus generated by the petroleum sector and would be four times the deficit of the agricultural sector.

On analyzing these figures it is also necessary to take into account that Mexico, unlike other petroleum producing countries whose surplus is the exclusive result of price increases, will have to establish its export industry during this Administration, and that will absorb a good portion of the surpluses generated during that period. This explains the fact that PEMEX demand for capital goods for the next ten years represents approximately 10% of the total world demand for this type of equipment during that same period.

The balance of payments projections for the period following 1982 clearly show that if significant changes are not brought about in the agricultural and capital goods sectors, the relative "financial self determination" produced by petroleum surpluses will quickly erode. Thus, it is essential that during this Administration an effort must be made to face the challenge of simultaneously creating a petroleum export industry and a capital goods industry that will be in a position to operate fully during the following Administrative period.

The group of 38 projects contained in the NAFINSA Capital Goods Program requires an investment of approximately 18,000 million pesos and is estimated to generate direct employment for 27,000 people. The investment per employee represents approximately one-ninth of the investment per man in the steel program. This gives an idea of the potential which this sector presents in terms of skilled labour.

It is estimated that the projects for expansion of existing enterprises, which are mainly designed to satisfy increases in demand for capital goods already being produced, will reach a level comparable to that of the NAFINSA investment program.

The investment to be carried out over the period from 1979-1982 represents a significant challenge because of its size, complexity, aspects of interrelation and the brief lapse of time available; it should not, however, be considered as an exhaustive effort that will cover all of the necessities for the future. It is, rather, a primary phase of construction of the capital goods industry: a process which will be realized over a period of not less than ten years. During the three years left in this Administration, the industrial goods program will be simply providing the basis for activities which will bring about a transformation in the industrial profile of the country. The true importance of this task resides precisely in the fact that this primary effort must establish a solid foundation for the vigourous growth of the capital good industry in the future.

4. Technological implications of the program.

An analysis of the group of projects under consideration reveals the following technological implications: 29/

- In terms of the basic infrastructure needed for satisfying all branches of industry, the program will create casting and forging capacities for pieces with unit weights over 50 tons. At the present time, open forge work barely covers half-ton pieces, and even then on a small scale. In some cases 15 ton steel castings have been produced but only for specialized products and, in general, it is difficult to obtain steel castings over 10 tons.

- The availability of large castings and forgings will mean an improvement in metallurgical quality and will ensure a supply of key parts required for achieving a truly adequate degree of integration in equipment used in the electrical energy industry, such as hydraulic and steam turbines and turbogenerators; moreover, it will establish the bases for internally supplying a series of products and components for which there is a large demand but which have had to be imported and often create difficulties in the manufacture of the products in which they are used: i. e. forged rolls for steel rolling, forged shafts for the sugar industry, ends and trunnions for ball mills, tires for cement mills, cast housings for turbines etc. In addition it prepares the way for establishing solid naval or locomotive manufacturing industries when they may be needed

and supplying those components for the petroleum and petrochemical industries which are, at present, imported.

- In platework, a traditional industry that enjoys a high degree of natural protection, the relevant projects will enable manufacturing of products of up to 300 tons (as opposed to the present limit of 100/75 tons) and plate thicknesses of up to 6 to 8 inches (in contrast to the current 4 inch maximun, under equivalent conditions).

- Higher-powered pumps will be available in new models and greater volume of national production. With more modern manufacturing machinery and higher-powered testing equipment, it can be realistically proposed that powerful multi-stage pumps will be produced for oilducts and boiler feeding, as well as large capacity pumps for supplying cities, industrial plants and large boilers.

- In the area of machine tools, there will be production of modern lathes for 80 ton pieces, with 18 or more meters between centers. Also, modern, floor-type boring and milling machines, with tables 3 meters wide, for large pieces.

- In addition, it is expected that there will be an integrated production of high quality, large-sized gears which would help to overcome one of the chief bottlenecks in the metalworking industry of today.

- Heat treatments, with all of their complexity, will be available on a large scale for large pieces, thus covering another of the industry's present deficiencies.

- For the mining industry, projects are directed toward providing heavy equipment with suitable quality and integration levels, so as to overcome the industry's problems of low integration and inadequate equipment whose limited size makes it unfit for mining and only useful for supplying the aggregates industry.

- Electrical equipment projects will be entering into an area that up until now has been non-existent in Mexico: turbines and turbogenerators. The challenge will be not only to establish such new production but also to achieve adequate levels of integration.

The non-existence of this kind of energy-producing equipment has been a key symbol of the lag in Mexican industry. The turbine and turbogenerator industry began during the latter part of the last century and the beginning of this century, in the advanced countries. Today, turbomachines are widely used not only for generating energy but also as primary motors for aviation, air and gas compression, as turboexpenders, etc. Since Mexico has undertaken the goal of creating, during this Administration, a nucleus of projects designed for shaping an industrial structure adapted to the demands of the modern world, it must enter into this field but not in terms of assembly or sub-contracting plants. It must integrally absorb

the technology involved and thus, also, the equipment needed for production, in much the same way that India has done and Brazil is doing at this time.

The manufacture of turbogenerators, in both medium and large sizes, implies creating the necessary conditions for resolving the technological problems presented by high-speed rotary parts. This technological advance is common to all turbomachines, such as axial and centrifugal turbocompressors, vertical water pumps, gas, turbines, etc. Control of fluids at high pressure requires cast steel casings.

- In order to satisfy the high pressure and hermetic qualities required in the large castings used in this field, it will be necessary to count on the highest quality foundry work possible; this will ensure an adequate and stable supply of the inputs needed for all of the products within the field of turbomachinery.

- The industrial branch receiving a preferential treatment at the present time because of the high degree of technological innovation involved in it, is the microelectronics industry. It is a branch that some authors include in what has been called "information technology" where all of the advances in electronics, computation and telecommunications come together to make the work of information organization, processing and transmission possible at a cost, speed, reliability and energy use that would not have been dreamed of in past years. 30/ The wide possibilities for application of microelectronics and its most typical element, the

microprocessor, have lead some authors to claim that the world is on the threashold of a second industrial revolution which will usher in a new "era of information" to replace the "era of power". 31/

Reference to this industrial sector is particulary significant because it not only illustrates the importance of keeping abreast of technological trends in specific branches, but is also underlined by the strong support that the governments of advanced countries provide for the most up-to-date technological advances.

It seems evident from the above, that the recommendations of "laissez faire" are not applied in the developed countries, or at least not in the area of the leading technologies, and this has a direct influence on their capacity for competing in the international market. In the specific case of microelectronics, there is no doubt that the industry will have a decisive influence on computing, telecommunications, measurement and control instruments, machine tools and processing plants; in integrated systems for health and education; and, naturally, in the military and aerospace industries. 32/

- In the area of design technology it must be pointed out that the research and development departments of the plants to be established will be made up of technicians whose capabilities range from the theoretical concepts of basic sciences to the empirical aspects of applied science. Turbogenerator design implies a thorough theoretical

and practical knowledge of design for units or machines that function partially on the basis of thermodynamic fluid processes, hydraulic, high-pressure viscous fluid processes, etc. Although each kind of equipment has its own design parameters, the technological advances achieved in the production of one of them is to some extent applicable to many others.

- The technological contributions that the program will provide in terms of manufacturing techniques will also be considerable: high quality vacuum degasified steels will be available in the alloys that may be needed for forgings and castings. These kinds of steel-making techniques together with those for forging large ingots, are, strictly speaking, a product of the post-war years (Second World War). The vacuum degasification of steel originated in Germany in the 1950's while argon refining was developed somewhat later on in the United States. Advances in forging techniques were made in England and other countries around the same time. Large ingots for forging used to be called "metallurgical monstrosities".

In short, the proposed projects will be creating an "era" of development for the capital goods industry, within an integrated, organic plan, and will attack also the major areas of limitations in technology.

- It is not assumed, however, that this group of investments will place Mexico's capital goods industry in a pre-eminent position; there is much yet to be done. Countries such as Spain, Brazil, and even South

Korea and Argentina still have a considerable lead, not only because of the activities that the list of projects does not include, such as equipment for nuclear plants, naval industry, locomotives, aviation equipment and others, but also because of the magnitude of the industrial undertakings of those countries.

One advantage that Mexico will have is that of learning from the experience of other countries and avoiding a repetition of the same errors; this should result in the formation of a more selective, integrated and, eventually, internationally competitive production structure.

This situation, together with strong political support, availability of resources and the systematic knowledge acquired in the sector, could turn what has been a relative lag into a future operational advantage.

ANNEX I

SUMMARY OF DEMAND FOR FORGINGS (FY 1980)

Tons and (%)

Weight ranges	Electricity generation	Mining equipment	Petroleum & Petrochemicals	Sugar industry	Rolls for the steel industry	Machine tools	Earth moving machinery	Steel industry (from pellets to continuous casting)	Turbo Machinery	Steel industry (only hot - rolled)	Cement	Railway axles	Total
					Forgings								
0.3 - 5	7.2 (7.2)	56.3 (66.1)	3633.1 (4887.4)	- (-)	4050.0 (14.2%)	198.5 (72)	27.5 (12%)	66.1 (63)	860.1 (91%)	1564 (55%)	35.5 (22.5)	7200 (20000)	16826.5 (38341.2)
5 - 10	122.1 (13.0)	86.5 (11.0)	198.1 (26.3)	168.0 (12)	- (-)	- (-)	- (-)	16.5 (2)	348.5 (4%)	176 (2%)	- (-)	- (-)	1069.2 (136.9)
10 - 30	198.0 (12.1)	32.2 (1.9)	- (-)	560.0 (3%)	3850.0 (24%)	- (-)	- (-)	133.0 (1%)	140.2 (1%)	195 (1%)	- (-)	- (-)	4308.4 (303.0)
30 - 60	444.2 (15.0)	6.2 (0.2%)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	160 (4)	- (-)	- (-)	551.4 (19.2%)
60 - 90	319.2 (5.6)	12.3 (0.2%)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	331.5 (5.8%)
90 - 80	123.5 (1.6)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	135 (2)	- (-)	- (-)	258.5 (3.6)
80 - 100	87.5 (0.6)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	87.5 (0.6)
100 - 200	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)
Total	1303.9 (55.9)	192.5 (72.3)	3831.2 (4132.9)	648.0 (48)	7900.0 (1634)	198.5 (72)	27.5 (12%)	288.1 (7%)	1255.0 (97%)	2372 (88%)	35.5 (22.5)	7200 (20000)	25804.2 (28856.2)

Note: In addition, export demand for a minimum of 3000 t. in the 30-60 ton range and a mean unit wt. of 15 t must be included.

TABLE 2

SUMMARY OF THE DEMAND FOR FOUNDRY UP TO 1980

Tons and Units

Weight ranges	Electricity generation	Mining equipment	Petroleum & Petrochemicals	Sugar industry	Rolls for the steel industry	Machine tools	Earth moving machinery	Steel industry (from pellets to continuous casting)	Turbo Machinery	Steel industry (only hot - rolled)	Cement	Railway axles	Total
						Fundición							
0.3 - 5	36.4 (11.4)	116.8 (45.8)	2922.57 (3510.5)	95.7 (123)	6250 (2500)	- (-)	92 (46)	560.9 (174)	146.5 (223)	52 (13)	- (-)	- (-)	9632.87 (6577.7)
5 - 10	51.0 (7.0)	524.7 (69.5)	- (-)	360.0 (45)	125 (55)	- (-)	25 (3)	351.8 (60)	174.0 (21)	140 (20)	- (-)	- (-)	1921.50 (290.5)
10 - 20	65.0 (6.0)	527.3 (38.2)	- (-)	- (-)	6000 (230)	- (-)	- (-)	176 (14)	50.5 (5)	600 (44)	217.5 (27.5)	- (-)	5712.3 (370.7)
20 - 40	307.1 (14.9)	337.1 (13.3)	- (-)	- (-)	- (-)	- (-)	- (-)	394 (17)	300.0 (11)	152 (6)	202.5 (7.5)	- (-)	1860.7 (69.3)
40 - 60	462.7 (9.4)	35.8 (0.75)	- (-)	- (-)	- (-)	- (-)	- (-)	190 (4)	- (-)	356 (7)	- (-)	- (-)	1044.5 (21.15)
60 - 80	- (-)	33.5 (0.5)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	33.5 (0.5)
80	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	1050 (5)	- (-)	- (-)	1050 (5)
Total	3002.2 (46.3)	1575.2 (167.5)	2922.57 (3510.5)	455.7 (168)	6375 (2785)	- (-)	117 (43)	1630.7 (269)	965.0 (256)	2524 (329)	520.0 (35.0)	- (-)	28885.37 (7287.7)

TABLE 1

SUMMARY OF DEMAND FOR PLATEWORK UP TO 2000

Tons and Units

Weight ranges	Electricity generation	Mining equipment	Petroleum & Petrochemicals	Sugar Industry	Rolls for the steel industry	Machine tools	Earth moving machinery	Steel industry (from pellets to continuous casting)	Turbo Machinery	Steel industry (only hot - rolled)	Cement	Railway axles	Total
						Pellets							
0.8 - 5	- (-)	- (-)	1567.4 (512.8)	- (-)	- (-)	67.34 (24)	- (-)	1155.6 (561)	74.4 (85)	16 (4)	- (-)	- (-)	3880.84 (1189.8)
5 - 15	- (-)	- (-)	7161.0 (840.7)	- (-)	- (-)	472.75 (39)	1113.1 (149)	694.2 (68)	285.6 (25)	24 (6)	- (-)	- (-)	9660.65 (1106.7)
15 - 30	- (-)	25.2 (1.6)	3723.4 (135.1)	- (-)	- (-)	- (-)	536.3 (33)	1372.5 (64)	- (-)	20 (1)	- (-)	- (-)	4675.4 (234.5)
30 - 50	- (-)	28.0 (0.7)	3952.8 (108.8)	- (-)	- (-)	- (-)	- (-)	656.0 (19)	- (-)	74 (2)	- (-)	- (-)	4710.8 (130.5)
50 - 100	151.3 (1.7)	363.8 (8.4)	3342.2 (69.0)	- (-)	- (-)	- (-)	- (-)	3215.4 (67)	- (-)	- (-)	- (-)	- (-)	7292.9 (146.1)
100 - 200	679.5 (5.2)	2081.0 (16.3)	8435.0 (64.0)	- (-)	- (-)	- (-)	- (-)	1291.0 (10)	- (-)	- (-)	- (-)	- (-)	12586.5 (95.5)
200 - 400	- (-)	- (-)	1002.6 (4.5)	- (-)	- (-)	- (-)	- (-)	1760.0 (7)	- (-)	- (-)	920 (2.5)	- (-)	4282.6 (14.0)
200	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	1000.0 (1)	- (-)	- (-)	- (-)	- (-)	1000.0 (1)
Total	830.8 (8.9)	2498.0 (26.0)	38884.4(1725.3)	- (-)	- (-)	540.19 (63)	3649.4 (182)	34899.9 (777)	360.00 (114)	134 (11)	920 (2.5)	- (-)	87080.0 (2888.0)

TABLE 4

SUMMARY OF DEMAND FOR HEAVY MACHINING UP TO 1980

Tons and Units

Weight ranges	Electricity generation	Mining equipment	Petroleum & Petrochemicals	Sugar industry	Rolls for the steel industry	Machine tools	Earth moving machinery	Steel industry (from pellets to continuous casting)	Turbo Machinery	Steel industry (only hot - rolled)	Cement	Railway axles	Total
					Magnitude	Pesada							
0.3 - 5	37.00 (12.0)	172.2 (105.3)	2607.7 (1488.7)	95.7 (123)	8300 (3847)	2[illegible]	144.5 (258)	480.0 (164)	1 132.8 (1139)	134 (65)	56.5 (22.5)	7200 (24000)	20 626.34 (31321)
5 - 10	76.78 (10.0)	611.2 (80.3)	661.9 (108.7)	468.0 (57)	925 (115.7)	472.75 (39)	- (-)	1131.2 (199)	526.5 (65)	238 (26)	- (-)	- (-)	5 111.33 (799.4)
10 - 20	179.16 (11.3)	574.7 (41.1)	1406.0 (103.3)	540.0 (36)	4000 (306.1)	- (-)	- (-)	235.0 (20)	190.7 (16)	371 (28)	287.5 (27.5)	- (-)	7 784.06 (491.4)
20 - 40	831.30 (28.0)	343.3 (13.5)	657.1 (24.6)	- (-)	- (-)	- (-)	- (-)	861.5 (29)	308.0 (11)	332 (14)	262.5 (7.5)	- (-)	3 595.7 (127.6)
40 - 60	829.90 (15.8)	48.2 (1.0)	438.0 (9.8)	- (-)	- (-)	- (-)	- (-)	260.0 (5)	- (-)	356 (7)	- (-)	- (-)	1894.1 (38.6)
60 - 80	75.60 (1.2)	49.2 (0.75)	- (-)	- (-)	- (-)	- (-)	- (-)	295.0 (4)	- (-)	564 (9)	- (-)	- (-)	983.8 (14.95)
80 - 100	208.90 (2.3)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	208.9 (2.3)
100 - 200	679.50 (5.2)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	1050 (8)	- (-)	- (-)	1729.5 (13.2)
Total	2918.14 (85.8)	1798.8 (342.7)	5752.7 (1736.3)	1163.7 (316)	13225 (4168.8)	738.69 (138)	144.5 (258)	3342.7 (421)	2 158 (1233)	3045 (157)	606.5 (57.5)	7200 (24000)	61 933.73 (32710)

TABLE 5

MEXICO: PRODUCTION ENVISAGED FOR THE PROJECT AROUND 1989

FOUNDRY

TONS AND UNITS

Weight ranges	[illegible]	Electricity generation	Mining equipment	Petroleum & Petrochemicals	Sugar industry	Rolls for the steel industry	Machine tools	Earth moving machinery	Steel industry (from pellets to continuous casting)	Turbo Machinery	Steel industry (only hot - rolled)	Cement	Railway autos	Total
						Fundición								
0.3 - 5	[illegible]		116.8 (45.8)	2922.57 (3510.5)	95.7 (123)	- (-)	- (-)	92 (40)	500.9 (174)	366.5 (222)	- (-)	- (-)	- (-)	[illegible]
5 - 10	51.0 [illegible]		836.7 (69.5)	- (-)	360.0 (45)	- (-)	- (-)	25 (3)	351.8 (60)	178.0 (21)	- (-)	- (-)	- (-)	[illegible]
10 - 20	65.0 (6.		[illegible].3 (38.3)	- (-)	- (-)	3830 (228)	- (-)	- (-)	174.0 (14)	50.5 (5)	- (-)	287.5 (27.5)	- (-)	5[illegible]
20 - 40	387.1 (14.5)		[illegible].3	- (-)	- (-)	- (-)	- (-)	- (-)	394.0 (17)	308.0 (11)	152 (6.0)	262.5 (7.5)	- (-)	[illegible]
40 - 80 g/	231.4 (4.7)		[illegible]	- (-)	- (-)	- (-)	- (-)	- (-)	95.0 (2)	- (-)	178 (3.5)	- (-)	-	[illegible]
Total	770.9 (41.0)	1521.		2922.57 (3510.5)	455.7 (168)	3830 (228)	- (-)	117 (43)	1515.7 (267)	903.0 (259)	330 (9.5)	550.0 (35.0)		[illegible]

Note: In the range 40-80 tons, fifty per cen[illegible] was assigned to the range 40-80 tons.

TABLE 6

MEXICO: PRODUCTION FORECASTED FOR THE PROJECT AROUND 1985

FOREIGN

TONS AND UNITS

Weight ranges	Electricity generation	Mining equipment	Petroleum Petrochem.	Sugar industry	Rolls for the steel industry	Machine tools	Earth moving machinery	Steel industry (items built in continuous casting)	Turbo Machinery		Cement	Railway axles	Total
						Events							
0.2 - 5	7.2 (7.2)	55.2 (60.1)	2633.	- (-)	3650.0 (1620)	198.5 (72	27.5 (129)	46.1 (63)	244.3 (917)	154 (	5 (22.5)	7200 (24000)	16620.5 (31561.3)
2 - 10	122.1 (13.3)	86.5 (11.0)	21.9	100.0 (12)	- (-)	- (-)	- (-)	10.0 (2)	348.5 (41)	176 (29)	)	- (-)	1049.2 (135.7)
10 - 20	190.0 (12.1)	22.3 (1.5)	(-)	500.0 (36)	3150.0 (210)	- (-)	- (-)	151.0 (13)	140.2 (13)	195 (18)		- (-)	4390.4 (303.6)
20 - 40	444.2 (15.0)	6.2 (0.	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	10) (4)	-	- (-)	551.4 (19.29)
40 - 50 q	139.6 (2.9)	6.4	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	(-)	165.6 (3.69)
Total:	923.1(38.48)	1	2831.2 (4121.9)	619.0 (19)	7200.0 (1950)	198.5 (72)	27.5 (129)	229.1 (76)	1255.0 (971)	2936 (648)	56.5 (22.5)		22708.3 (32002.79)

NOTE: In the range 40-50 [illegible] per cent of the weight was assigned to the range 10-50 tons.

TABLE 5

MEXICO· PRODUCTION ENVISAGED FOR THE PROJECT AROUND 1989

FOUNDRY

TONS AND UNITS

Weight ranges	Electricity generation	Mining equipment	Petroleum & Petrochemicals	Sugar industry	Rolls for the steel industry	Machine tools	Earth moving machinery	Steel industry (from pellets to continuous casting)	Turbo Machinery	Steel industry (only hot - rolled)	Cement	Railway axles	Total
					Fundición								
0.3 - 5	36.4 (11.4)	116.8 (45.8)	2922.57 (3510.5)	95.7 (123)	- (-)	- (-)	92 (40)	500.9 (178)	366.5 (222)	- (-)	- (-)	- (-)	6130.87 (4126.7)
5 - 10	51.0 (7.0)	536.7 (69.5)	- (-)	360.0 (45)	- (-)	- (-)	25 (3)	351.9 (60)	178.0 (21)	- (-)	- (-)	- (-)	1490.50 (2[illegible]
10 - 20	65.0 (4.0)	527.3 (38.3)	- (-)	- (-)	3830 (220)	- (-)	- (-)	174.0 (14)	50.5 (5)	- (-)	387.5 (27.5)	- (-)	6934.30 (31[illegible]
20 - 40	387.1 (14.3)	337.1 (13.3)	- (-)	- (-)	- (-)	- (-)	- (-)	394.0 (17)	308.0 (11)	152 (6.0)	262.5 (7.5)	- (-)	1860.70 (69.[illegible]
40 - 90 g/	231.4 (4.7)	17.9 (0.375)	- (-)	- (-)	- (-)	- (-)	- (-)	95.0 (2)	- (-)	178 (3.5)	- (-)	- (-)	522.30 (10.57[illegible]
Total	770.9 (41.6)	1523.8 (667.075)	2922.57 (3510.5)	455.7 (168)	3830 (220)	- (-)	117 (43)	1515.7 (367)	903.0 (255)	330 (9.5)	530.0 (35.0)	- (-)	18918.67 (4729.67[illegible]

Note: In the range 40-90 tons, fifty per cent of the weight was assigned to the range 40-90 tons.

TABLE 6

MEXICO: PRODUCTION EXPECTED FOR THE PROJECT AROUND 1990

FOREIGN

TONS AND UNITS

Weight ranges	Electricity generation	Mining equipment	Petroleum & Petrochemicals	Sugar industry	Rolls for the steel industry	Machine tools	Earth moving machinery	Steel industry (forge pieces in continuous casting)	Turbo Machinery	Steel industry (only hot - rolled)	Cement	Railway axles	Total
					Forge								
0.2 - 5	7.2 (7.2)	55.3 (60.1)	3633.1 (4097.4)	- (-)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	154 (55%)	56.5 (22.5)	7200 (24000)	16424.5 (31561.2)
5 - 10	132.1 (13.2)	86.5 (11.6)	198.1 (21.5)	168.0 (12)	- (-)	- (-)	- (-)	10.0 (2)	348.5 (41)	176 (25)	- (-)	- (-)	1669.2 (135.7)
10 - 20	190.0 (12.1)	22.2 (1.5)	- (-)	540.0 (36)	3150.0 (210)	- (-)	- (-)	153.0 (13)	140.2 (13)	195 (30)	- (-)	- (-)	4390.4 (303.6)
20 - 40	444.2 (15.8)	4.2 (0.25)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	140 (4)	- (-)	- (-)	551.4 (19.25)
40 - 80 g	130.4 (2.9)	6.2 (0.13)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	165.8 (3.03)
Total:	923.1(850.4)	176.4(72.%)	2831.2 (4121.9)	648.0 (1%)	7200.0 (1%)	148.5 (7%)	27.5 (1%)	229.1 (7%)	1255.0 (%)	24% (60%)	56.5 (22.5)	7200 (24000)	33781.3 (33002.7%)

NOTE: In the range 40-80 tons, fifty per cent of the weight was assigned to the range 20-50 tons.

TABLE 7

MEXICO PRODUCTION ENVISAGED FOR THE PROJECT AROUND 1980

HEAVY MACHINING

TONS AND UNITS

Weight ranges	Electricity generation	Mining equipment	Petroleum & Petrochemicals	Sugar industry	Rolls for the steel industry	Machine tools	Earth moving machinery	Steel industry (from pc' to continuous casting)	Turbo Machinery	Steel industry (only hot - rolled)	Cement	Railway axles	Total
					Requirements		Periods						
0.3 - 5	37.60 (12.6)	172.2 (105.0)	2697.7 (1159.7)	95.7 (129)	8790 (3547)	67.11 (23)	111.5 (259)	490.9 (164)	366.5 (222)	134 (69)	54.5 (22.5)	7200 (20000)	19961.56 (28332.6)
5 - 10	76.78 (10.6)	611.2 (88.5)	461.0 (166.7)	668.6 (57)	925 (115.7)	472.75 (39)	- (-)	1131.3 (199)	178.0 (22)	218 (24)	- (-)	- (-)	4762.03 (657.5)
10 - 20	179.16 (11.3)	574.7 (41.1)	1486.0 (183.5)	540.0 (36)	4000 (296.11	- (-)	- (-)	235.0 (29)	50.5 (5)	371 (29)	207.5 (27.5)	- (-)	7643.86 (670.5)
20 - 40	831.30 (28.6)	343.3 (13.5)	657.1 (31.6)	- (-)	- (-)	- (-)	- (-)	861.5 (29)	348.0 (11)	332 (14)	252.5 (7.5)	- (-)	3885.7 (137.6)
40 - 50 g/	414.96 (7.5)	24.1 (0.5)	230.9 (4.5)	- (-)	- (-)	- (-)	- (-)	130.0 (2.5)	- (-)	178 (3.5)	- (-)	- (-)	947.06 (18.5)
Totales	1539.19 (69.3)	1725.5 (241.4)	5542.7 (1730.4)	1303.7 (356)	13225 (4160.11)	540.19 (62)	111.5 (259)	2857.7 (414.5)	983.0 (254)	1253 (136.5)	686.5 (57.5)	7200 (20000)	39610.90 (29618.5)

Note: In the range 40-60 tons, fifty per cent of the weight was assigned to the range 40-50 tons.

TABLE 3

MEXICO: PRODUCTION ENVISAGED FOR THE PROJECT OF FORGINGS AND FOUNDRY

Structure by type of equipment within a weight ranges

	Weight ranges	Electricity generation	Mining equipment	Petroleum & Petrochemicals	Sugar industry	Rolls for the steel industry	Machine tools	Earth moving machinery	Steel industry (from pellets to continuous casting)	Turbo Machinery	Steel industry (only hot - rolled)	Cement	Railway axles
		%	%	%	%	%	%	%	%	%	%	%	%
FORGINGS	0.3 5	0.78	31.35	93.00	-	56.70	100.00	100.00	23.95	61.06	76.82	100.00	100.00
	5 10	13.23	49.02	7.00	16.70	-	-	-	4.36	27.77	8.64	-	-
	10 20	20.58	12.59	-	83.30	43.70	-	-	66.79	11.17	9.58	-	-
	20 40	48.12	3.51	-	-	-	-	-	-	-	4.96	-	-
	40 50	17.29	3.51	-	-	-	-	-	-	-	-	-	-
		100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
FOUNDRY	0.3 5	4.72	7.67	100.00	100.00	-	-	78.60	31.05	40.39	-	-	-
	5 10	6.62	34.43	-	-	-	-	21.40	23.21	19.71	-	-	-
	10 20	8.43	34.60	-	-	100.00	-	-	11.48	5.60	-	52.30	-
	20 40	50.21	22.12	-	-	-	-	-	26.00	34.10	46.06	47.70	-
	40 50	30.02	1.18	-	-	-	-	-	6.26	-	53.94	-	-
		100.00	100.00	100.00	100.00	100.00	-	100.00	100.00	100.00	100.00	100.00	100.00
MACHINING	0.3 5	2.40	9.97	47.04	8.67	62.70	12.50	100.00	17.00	40.60	10.70	9.30	100.00
	5 10	4.99	35.42	11.93	42.30	7.00	87.50	-	40.00	19.70	19.00	-	-
	10 20	11.64	33.31	25.40	48.93	30.24	-	-	8.30	5.60	29.60	47.40	-
	20 40	54.00	19.00	11.86	-	-	-	-	30.50	34.10	26.50	43.30	-
	40 50	26.96	1.40	3.77	-	-	-	-	4.20	-	14.20	-	-
		100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Note: Exports not included

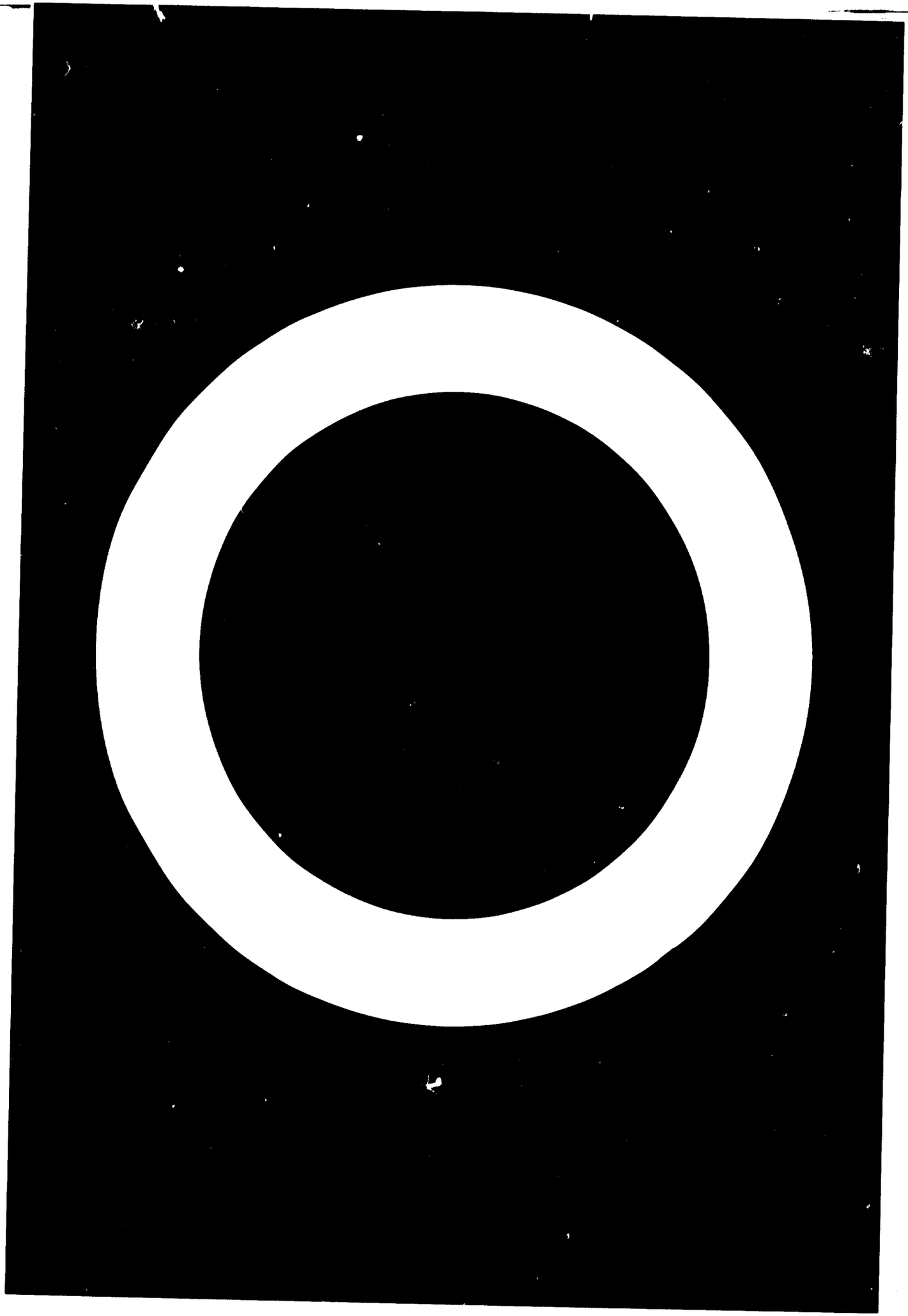
TABLE 7

MEXICO: PRODUCTION ENVISAGED FOR THE PROJECT OF FORGINGS AND FOUNDRY

Structure by type of equipment within a weight ranges

	Weight ranges	Electricity generation %	Mining equipment %	Petroleum & Petrochemicals %	Sugar industry %	Rolls for the steel industry %	Machine tools %	Earth moving machinery %	Steel industry (from pellets to continuous casting) %	Turbo Machinery %	Steel industry (only hot - rolled) %	Cement %	Railway autos %	
FORGINGS	0.3 5	0.04	0.33	15.84	-	21.10	1.20	0.17	0.40	4.61	9.41	0.34	43.31	100.00
	5 10	11.65	8.30	18.90	10.36	-	-	-	0.95	33.20	16.80	-	-	100.00
	10 20	4.33	0.51	-	12.30	71.75	-	-	3.50	3.20	4.40	-	-	100.00
	20 40	80.56	1.12	-	-	-	-	-	-	-	18.32	-	-	100.00
	40 50	96.26	3.74	-	-	-	-	-	-	-	-	-	-	100.00
	Total	4.05	0.77	12.43	2.84	31.61	0.87	0.12	1.01	5.51	8.94	0.25	31.61	100.00
FOUNDRY	0.3 5	0.88	2.83	70.75	2.32	-	-	2.23	12.12	8.87	-	-	-	100.00
	5 10	3.42	35.20	-	21.15	-	-	1.68	23.60	11.94	-	-	-	100.00
	10 20	1.32	10.69	-	-	77.62	-	-	3.53	1.03	-	5.82	-	100.00
	20 40	21.03	18.31	-	-	-	-	-	21.40	16.73	8.26	14.26	-	100.00
	40 50	44.30	3.43	-	-	-	-	-	18.19	-	34.08	-	-	100.00
	Total	5.97	11.80	22.62	3.53	29.65	-	0.91	11.73	6.99	2.55	4.26	-	100.00
MACHINING	0.3 5	0.18	0.81	12.61	0.48	41.21	1.29	0.70	2.33	5.50	0.65	0.27	34.90	100.00
	5 10	1.50	11.96	13.08	9.16	18.10	9.30	-	22.13	10.30	4.65	-	-	100.00
	10 20	2.30	7.38	18.06	6.94	51.39	-	-	3.02	2.15	4.76	3.70	-	100.00
	20 40	23.12	9.55	19.29	-	-	-	-	23.96	8.57	9.24	7.30	-	100.00
	40 50	43.82	2.54	22.19	-	-	-	-	12.67	-	18.79	-	-	100.00
	Total	4.04	4.53	14.54	2.90	11.71	1.94	0.38	7.42	5.67	3.30	1.60	18.98	100.00

Note: No se incluye las exportaciones.



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28/ *Horizontal boring machines, portal-type plano-milling machines and vertical turning lathes, radial and column drills, motor scrapers, scrapers, scrapers and power shovels for mining, Caterpillar front-end loaders, trenchers and LHD equipment, crushing and grinding equipment for mining, equipment for the dairy industry.*

29/ *See: J. Ayza's report on the supply of capital goods.*

30/ *This is evident on comparing the characteristics of one of the first electronic computers, ENIAC built in the 1940's at a cost of several million dollars and present-day equipment based on microprocessors which can be produced for less than 100 dollars and whose circuits would be 20 times faster than ENIAC, 10,000 times more reliable, and would require 56,000 times less power and 1/300,000 less space. See: "Intellectual and Economic Fuel for the Electronics Revolution", J.G. Linvill and C.L. Hogan, Science, Vol. 195, 1977, pp. 1107-1113.*

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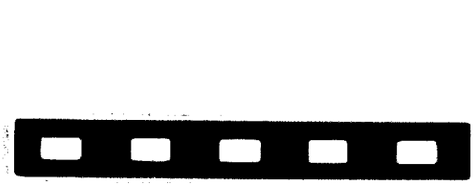

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