OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

Distr.
LIMITED

ID/WG.508/1(SPEC.)
4 October 1990

ENGLISH
ORIGINAL: FRENCH/
ENGLISH/SPANISH

18136

United Nations Industrial Development Organization

Regional Expert Group Meeting for
Latin America on the Capital Goods
Industry with Emphasis on Machine Tools

Santiago, Chile, 8-11 April 1991

MACHINE TOOLS IN MEXICO*

by

M. Humbert**
UNIDO Consultant

* The opinions expressed in this document are those of the author and do not necessarily reflect those of the UNIDO Secretariat. This document has not been formally edited.

** GERDIC, University of Rennes I, 7 place Kocha, 3500 Rennes (France).

V.90 82841 7589e

CONTENTS

INTRODUCTION

1. The overall economic situation

The Mexican economy has been extremely dynamic since 1940, with Mexico gradually becoming the second economic power in Latin America, behind Brazil and in front of Argentina. The annual growth rate of its real gross domestic product remained above 6 per cent most of the time between 1940 and 1980, or twice as much as that of the population, whose per capita income has therefore increased by about 3 per cent per year over this long period. This performance has placed Mexico among the new industrial countries.

	1940-1947	1947-1958	1958-1970	1970-1980
Mean annual growth rate of Mexican GDP	6.7%	6.1%	6.7%	6.7%

Source: Marc HUMBERT, Le Mexique, P.U.F., 1986, p. 79.

The 1980s, on the other hand, were much less favourable, with negative growth rates in 1982, 1983 and 1986, and slightly positive ones (except at the beginning of the period), which should give us a mean annual growth rate for the GDP of a little more than 1 per cent. Since the population continued to increase fairly actively at a rate slightly higher than 2 per cent, the mean per capita income will therefore have lost an average of 1 per cent a year during the decade.

If we consider the international statistics, expressed in dollars, the impoverishment appears even greater.

	GNP/per capita dollars 1984	Population 1987 (millions)	GNP/per capita dollars 1987	Mean annual growth rate GNP/per capita 1965-1987
Argentina	2 230	31.1	2 390	0.1
Brazil	1 720	141.4	2 020	4.1
Mexico	2 040	81.9	1 830	2.5

Source: World Bank, Reports for 1986 and 1989.

Mexico, which in 1984 had been classed by the World Bank among the third world countries with a revenue in the middle of the higher bracket, dropped down again in 1987 to the lower bracket. There is no point here in entering into a detailed discussion of the statistics, but it is important nevertheless to point out that the very fast though differing movements of prices and rates of exchange in Latin America make international comparisions invalid and make it difficult, for example, to enter into arguments about figures adjusted for an annual rate of exchange,

when the latter is varying all the time and in a non-uniform manner. Hence we will use in this report the data for constant prices in national currency, except in the case of foreign trade, where the values in dollars are those recorded (and not calculated at a rate of exchange).

The crisis in the 1980s was an occassion to cast doubt all at once on: (1) the hypotheses on the basis of which it was believed at the time that the Mexican economic policies could be judged; (2) the industrialization strategies of the past which had permitted the long period of growth; and (3) the hopes for a speed-up which were raised at the end of the 1970s.

First of all, Mexico should have been considered as no longer being mainly agricultural, rural and likely to find its sources of accumulation in the countryside. While it is true that 40 per cent of the population still lives in the countryside and that nearly 38 per cent of the population is actively engaged in agriculture and stockbreeding, this situation is the reverse of what was the case at the beginning at the 1960s. Similarly, the large foreign balance engendered in the past by agricultural activities has become eroded. The strategies to be elaborated should therefore be based on a Mexico that is urban as well as industrial and tertiary.

The industrialization strategies since the 1940s have been based on strong protectionism permitting the replacement of imports by a private industry for the production of consumer goods, gradually including durable consumer goods this time, notably, with the support of multinational firms. Over the same period, the basic industries were taken over by the State either totally or partially (iron and steel, energy, petrochemicals), with the import replacement industry being offered raw materials and subsidized intermediate commodities. The component parts of the industrial apparatus built up in that manner functioned with a degree of efficiency that was a long way from international standards, even though the world economy was entering a critical period and was witness to a formidable technological transformation that was steadily forcing up those standards. It was therefore important to recombine the intensive operational modes and structures with what "industrial" meant at the time at planetary level so as to get round the blocks encountered in the attempts to bring about progress in an archaic industrial system. The industrialization strategies had to concern themselves with restructuring, modernizing and being competitive at international level and not just with producing for a domestic market as best it could and, if need arose, with the help of State enterprises with deficits.

Finally, the strong rallying of oil prices, under the Mexican operating conditions of the time, boosted the potential of PEMEX, the national oil (and basic petrochemical) company. Its production and its exports soared; gaining still more from the second oil crisis in 1979, the Mexican economy seemed able to cope with internal difficulties and afford modern equipment - without producing it - while still keeping the protection of the somewhat inefficient industries and a considerable State apparatus, putting off for the time being the cleaning-up and opening-up operations that the IMF, called upon during the boom of 1976, had recommended. An era of easy prosperity seemed to get in; direct investors and international bankers viewed the new industrial country teeming with oil resources on the doorstep of the United States as an economy on which they could bank. The oil countershock in 1982 turned that mood of speculative enthusiasm into a grave crisis. The Mexican economy had not been restructured, its debt and the debt service were huge; the oil had not enabled it to cope with them; there would have to be a considerable tapping of domestic resources and the medicine recommended by the IMF would have to be swallowed, namely to devalue, throw open the frontiers and privatize.

Such was the fate of much of the third world, especially Latin America, where they were undergoing, furthermore, a hyperinflation of three or even four figures. Mexico would be considered as the obedient pupil of the IMF, building up very soon considerable foreign surpluses at the price of an appreciable cut-down on imports, while still dismantling, slowly at first, the protection and privatization and seeking a way of industrial restructuring. The recession of 1986 convinced a number of highly placed people that it would have to go even further, especially when it became a new member of GATT and that Latin America would not manage to establish a defensive front.

Growth started up again, albeit modestly, in 1987 and 1988. The 1988 exports of more than $21,000 million were fairly diversified: oil did not account for more than 28 per cent, while the manufacturing industry contributed 61 per cent. Furthermore, the internationally sub-contracted "assembly plant" activities for export yielded a surplus of almost $2.5 thousand million. The balance of payments, however, required much greater capital returns, since growth could not take place without importing, while $9,000 million still had to be spent in 1988 on paying interest on the debt. A certain degree of international confidence favoured the rescheduling of the debt, while, despite a highly controversial election, the new Government introduced a social pact which made it possible, in particular, to reduce inflation to 52 per cent in 1988, and perhaps to a little less than 20 per cent in 1989. Concurrently, Mexico continued to accept major direct foreign investments, mainly from the United States, which covered almost two thirds of the foreign investment stock ir Mexico.

Flow of direct foreign investments
(millions of dollars)

	1981	1982	1983	1984	1985	1986	1987	1988
Total	1 702	627	684	1 442	1 871	2 421	3 877	3 157
Manufacturing industry			1 430	1 729	2 421	1 916	2 400	1 020

Source: General Directorate for Foreign Investments, 31 December 1981.

2. Manufacturing industry and capital goods sector

Mexico's industrial policy on import substitution has not permitted the real development of capital goods production. Indeed, the capital goods industry has not had protection. The World Bank report for 1979 stress (p. 130) that: "The relatively low level of protection of the industry deserves mention". A preference was given to foreign suppliers who offered, in addition, financial facilities that the local suppliers could not afford. This preference was given, in particular, by the Mexican public enterprise "government agencies and the private sector have in general found it easy to import capital equipment". The public enterprises benefited from "unlimited access to imported equipment at zero tariff rates" (ibid., p. 56). This situation did not appear to disturb the Government authorities, for whom national investment priorities concerned the production of durable goods, with disregard for capital goods.

Although, as in most economies, the capital goods sector follows the growth rate of the manufacturing value added and increases it, the Mexican sector, on the other hand, represents a much smaller proportion than elsewhere of the manufacturing industry. The following table (UNIDO, 1987, p. 3) is relatively optimistic. Of the national data at fixed prices, the proportion of capital goods is 22 per cent in 1981, and 16 per cent in 1983 (see our table, page 7. In most countries within this group, 1/ the most important item is non-electrical machinery and equipment. In the table we see that this is the case in most countries, except for Mexico (and Korea). In its report on the engineering industries, the Economic Commission for Europe points out the overall importance of this item and states: "The major group ISIC 382 still constitutes the core of the engineering industries", and stresses that its share in this industrial group is usually greater than 30 per cent. According to our calculations for national data (see table on page 8) in fixed currency, this share was less than 16 per cent for Mexico.

1/ In the international classification the group referred to is called ISIC 38 and the most important item in it is ISIC 382. The machine tools are to be found in subdivision ISIC 3823. Refer to the annex at the end of the section for problems of nomenclature.

Machinery and equipment industries within the manfuacturing sector, selected countries

	All machinery and equipment production	Metal products	Non-electrical machinery	Electrical machinery	Transport equipment	Precision instruments
A. OECD countries						
Japan	45.9	6.6	12.6	14.1	10.8	1.8
United States	47.0	7.3	14.2	10.1	11.6	3.8
Federal Republic of Germany	50.9	6.2	14.7	13.1	14.5	2.4
B. Latin American countries						
Brazil	32.5	5.3	11.2	7.1	8.1	0.8
Mexico	28.8	6.9	5.4	6.4	9.2	0.9
C. Asian developing countries						
India	29.8	3.4	8.9	8.0	8.8	0.7
Republic of Korea	28.0	4.4	4.0	10.0	8.5	1.1

Source: UNIDO, Handbook of industrial statistics, 1986, Vienna, 1986.

Note: Figures are the average for 1982-1984. All machinery and equipment industries correspond to ISIC 38; the figure in this column is the sum of the following five columns which correspond to ISIC 381, 382, 383, 384 and 385 respectively.

Added value in millions of pesos, 1970

	1981	1982	1983	1984	1985	1986	1987	1988
GDP total	908 765	903 839	856 174	887 647	912 334	878 085	893 890	
MVA	224 326	217 852	202 026	213 166	226 197	216 164	221 135	
MVA/GDP total	24.7%	24.1%	23.6%	24.0%	24.8%	24.6%	24.7%	
Metal products, machines and equipment (part of ISIC 38)	49 162	42 970	33 168					
Div. VII/MVA	29.9%	19.7%	16.4%					
51 non-electrical machinery and equipment (= ISIC 382)	7 968	6 580	3 035					
51/Div. VIII	16.0%	15.3%	15.2%					
51/MVA	3.6%	3.0%	2.5%					

Annual growth rate in percentage

	1981	1982	1983	1984	1985	1986	1987	1988	1989
GDP total	7.9	-0.5	-5.3	3.7	2.8	-3.8	1.8	1.1	3.5
MVA	7.0	-2.9	-7.3	5.5	6.1	-4.4	2.3	2.2	6.0
Div. VIII	10.6	-12.6	-22.8						
51	10.6	-17.4	-23.5						

Source: Mexican national accounting system, 81-83, INEGI 1984, p. 16, Latin American Economic Report, LAER 89-12, December 1989, p. 2.

GDP: gross domestic product MVA: manfuacturing value added.

511. Industrial machinery and equipment
(millions of pesos 1980)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
P = production	2 720	3 039	3 801	4 575	5 215	5 184	6 134	6 058	5 671	8 301	8 968	10 227	8 662	6 522
Growth rate P		11,7 %	25,1 %	20,4 %	14,0 %	- 0,6 %	18,3 %	- 1,2 %	- 6,4 %	46,4 %	46,4 %	8,0 %	- 15,3 %	- 24,7 %
X = exports	640	758	862	939	1 942	704	860	1 124	797	1 074	1 181	1 811	1 504	328
M = imports	16 524	16 368	18 423	24 811	23 508	28 668	24 580	19 968	27 043	41 474	57 632	64 570	33 128	6 337
1-(M/P + M-X)	11,2 %	12,2 %	13,8 %	12,8 %	12,2 %	13,5 %	17,7 %	19,8 %	15,3 %	14,8 %	11,9 %	11,5 %	17,8 %	49,4 %
P/K	3,7 %	4,1 %	4,5 %	4,5 %	4,8 %	4,3 %	5,0 %	5,2 %	4,0 %	5,0 %	4,9 %	4,9 %	5,0 %	4,8 %
M/MK	32,4 %	35,9 %	29,5 %	31,8 %	30,4 %	38,0 %	36,9 %	35,2 %	39,8 %	37,6 %	38,3 %	35,6 %	37,9 %	17,5 %

Total capital goods
(millions of pesos 1980)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
K = production	72 677	73 983	85 340	101 126	109 689	119 198	123 230	117 362	143 419	165 144	184 841	210 431	174 479	132 889
Growth rate K	-	1,8 %	15,4 %	18,5 %	8,5 %	8,5 %	3,4 %	- 4,8 %	22,2 %	15,1 %	11,9 %	13,8 %	- 17,1 %	- 23,8 %
XK = exports	2 067	3 082	4 137	7 041	7 874	6 177	5 767	9 190	8 135	11 218	9 904	11 585	7 041	4 145
XK/K	2,8 %	4,2 %	4,8 %	7,0 %	7,2 %	5,2 %	4,7 %	7,8 %	5,7 %	6,8 %	5,4 %	5,5 %	4,0 %	3,1 %
MK = imports	50 936	45 558	62 440	78 015	77 259	75 501	66 567	56 763	67 982	110 345	150 618	181 440	87 523	36 319
1 - (MK/K + MK - XK)	58,1 %	60,9 %	56,5 %	54,7 %	56,9 %	60,0 %	63,8 %	65,6 %	66,6 %	58,2 %	53,7 %	52,3 %	65,7 %	78,0 %
1 - ΔM/ΔP - ΔX + ΔM)	66,6 %	70,2 %	64,0 %	63,0 %	64,7 %	69,9 %	72,8 %	73,7 %	76,1 %	68,1 %	64,3 %	62,0 %	74,7 %	80,3 %

Note: Capital goods: 491 + 510 + 511 + 512 + 513 + 514 + 515 + 518 + 520 + 521 + 542 + 560 + 580 + 581 + 582 + 583.

$\Delta M = MK - M$, $\Delta X = XK - X$, $\Delta P = K - P$.

See annex for nomenclature.

Within the non-electrical machinery and equipment group the item of most direct interest to us is that of industrial machinery and equipment. 2/ Study of it shows a situation that is very different for capital goods as a whole. The main difference relates to the self-supply rate. For example, between 1970 and 1975, coverage of local supply by domestic production approached 60 per cent for capital goods as a whole, whereas it hardly passed 12 per cent for industrial machinery and equipment. Mexican industry therefore equips itself principally with imported machinery, and the imports represent almost a third of all the Mexican capital goods imports. If we exclude industrial machinery and equipment from capital goods as a whole, the latter then has a domestic market coverage rate averaging more than 66 per cent over the period from 1970 to 1975, which even approaches 70 per cent over the period 1976-1981. This structural situation does not alter to any great extent in time, as shown, for example, by the share of the production of industrial machinery and equipment in the total production of capital goods: it moves from an average of 4.3 per cent in 1970-1975 to 4.8 per cent in 1976-1981, or by its share in the imports, which rises from 3 per cent to 37.2 per cent. Local production has not increased its share of the domestic market, which began to develop at the end of the 1970s and became very important in 1981.

However, it was during that period that a programme was implemented for the development of the Mexican capital goods industry with the help of UNIDO and with NAFINSA (National Investment Bank) as the Mexican partner (1977).

Indeed, between 1977 and 1984, NAFINSA promoted the establishment of 12 enterprises making capital goods, more particularly for agriculture and the oil, chemical and iron and steel industries (for forging, casting and the manufacture of large diameter piping), but no enterprises manufacturing machine tools. Over the same period the financial bodies and funds administered by NAFINSA or other organizations offered various facilities, including for export (see following table). An ECLA/UNIDO joint division has also been trying, since the beginning of the 1980s, to promote the capital goods industry in the Latin American countries. The instruments available in Mexico do not appear in any way inferior to those of the larger countries, such as Brazil and Argentina, yet the results obtained are extremely mediocre.

In the overall sense, the performance abroad of the manufacturing sector went down at the end of the 1970s, and the oil revenues, by increasing tenfold, also increased tenfold the manufacturing imports.

2/ Item 5.1.1 of the Mexican nomenclature, which contains, among others, subdivison 5.1.1.1 (or the equivalent of ISIC 3823) for woodworking and metalworking machines.

Support from existing funds

Financial support organizations / Field or type of financial support	FOMEX	FONEI	FOGAIN	FOMIN	FONEP	Co-investment funds	NAFINSA	BANCA SOMEX	BANCOMEXT
1. Risk capital				X		X	X	X	
2. Technical advice	X	X	X	X	X	X	X	X	X
3. Pre-investment studies		X	X		X				
4. Fixed asset acquisitions		X	X			X	X		
5. Working capital	X		X				X	X	X
6. Capital goods sales abroad	X								
7. Sales abroad	X								
8. Stocks of goods	X		X				X		
9. Mortgage credit								X	
10. Guaranttes	X		X				X		
11. Production	X								
12. Technological development of capital goods*		X							
13. Acquisitions of imported machinery and equipment (global credit lines)							X		
14. Counter-receipt financing	X								

* Now completing the formalities for credit from the World Bank in the amount of $127 million.

Source: Calculations of the NAFINSA-UNIDO joint capital goods project management.

Source: NAFINSA. 1985 (p. 266).

Some indications on the availability of financing of sales for capital goods

Country	Internal market	Availability of financing for exports for : General and prepatory costs (including studies)	Pre-shipping costs	Post-shipping costs	Availability of guarantees and/or export credit insurance
Argentina	X	X	X	X	X
Bolivia	X	X	X	X	X
Brazil	X	X	X	X	X
Colombia	X	X	X	X	X
Ecuador		X	X	X	
Mexico	X	X	X	X	X
Peru	X	X	X	X	X
Uruguay					X
Venezuela	X	X	X	X	X
SAFICO				X	
BLADEX				X	
BID				X	

Source : UNIDO (1984), p. 89.

Available credit facilities for the export of capital goods in selected countries

Country	Terms for pre-shipping period			Terms for post-shipping periode		
	Credit (% of total amount)	Maximum duration (years)	Interest rate (% p.a.)	Credit (% of total amount)	Maximum duration (years)	Interest rate (% p.a.)
Argentina	85	1	2,5	85	8,5	7,5
Bolivia	80	2/3	12	80	1	10
Brazil	a/	1	40 b/	85	5-8 or more	7,5-8
Colombia	80	1/2	19 b/	100	5-10	
Ecuador	80	1	6	80	5 or more	7 c/, 12,5 d/
Mexico	85	variable	8	85	8,5-10	7,75
Peru	70	1	56 b/	90	5	10,25-12
Venezuela	80-100	variable	6	100	5 or more	7

a/ Depending on value
b/ National currency
c/ First year
d/ In each following year

Source: ECLA/UNIDO joint division, Guide for description of incentive mechanisms for the production and marketing of capital goods and related services, August 1982.

Taken from UNIDO (1984), p. 91.

Domestic production apparatus has not been able to meet the demand and the greatest share of imports has been that of finished products, resulting in record industrial deficits: $17,000 million in 1981. In 1983 the deficit dropped to a little more than $1,000 million: exports increased by about 60 per cent and imports were divided by more than three.

Foreign trade in manufactured products 1981-1988
(millions of dollars)

	1981	1982	1983	1984	1985	1986	1987	1988
Exports	3 427	3 167	5 448	6 986	6 720	7 800	10 588	12 381
Imports	21 018	12 956	6 444	9 122	11 533	10 300	10 771	16 747
Balance	-17 591	-9 789	-1 196	-2 136	-4 813	-2 500	-183	-4 366

Source: Mexican foreign trade, various reports.

The import of non-electrical and non-electronic machinery and equipment has been divided by more than four. Since 1985 manufacturing imports have gone down to more than 50 per cent of what they were in 1981, but with exports which have doubled with respect to this period. The export of non-electrical machinery and equipment remains, on the other hand, negligible, whereas it was not until 1988 that the imports exceeded half of what they were in 1981.

Imports of non-electrical machinery and equipment 1981-1988
(in millions of dollars)

	1981	1982	1983	1984	1985	1987	1988
Amount	6 288	3 942	1 528	1 980	2 640	2 843	3 728

Source: Mexican foreign trade, various reports.

The production of capital goods has not developed and the modest investment rate (19 per cent of the GDP between 1983 and 1988) does not encourage an increase in imports. This apathy concerns more particularly the machine tool sector where the amounts of exports are negligible compared with imports, which in 1988 had still not reverted to their 1981 level.

Imports of metalworking machinery
(in millions of dollars)

	1981	1982	1983	1984	1985	1986	1987	1988
Amount	716	606	257	255	211	225	174	310

Source: See previous tables.

Note: This heading corresponds to SITC 73.

The national development plan adopted in mid-1989 provides for a rise in the investment rate to 23 per cent of the GDP, then to 26 per cent after 1991; it is obviously essential to ensure the growth of national production. Nevertheless, since the domestic supply of investment goods is very low, the accumulation of capital can only be made by relaunching imports, unless Mexico receives direct investments in this area. The new law of May 1989 3/ shows that for the production of machinery (machinery, apparatus and spare parts), direct majority foreign investment, even with total foreign control, is possible without authorization. It is too soon to tell whether this provision will lead to the formation, for the production of machine tools, of a local industrial fabric that is more substantial than the very limited one that now exists and which we will describe further on.

3/ Law governing the promotion of Mexican investment and regulating foreign investment.

Annex on nomenclatures

Division XIII, which corresponds to part of ISIC 38 Division, Metal products, machinery and equipment, covers 11 groups (48-58), two of which are not always considered capital goods (either by NAFINSA or UNIDO).

48 Metal furniture (ISIC 3812)

53 Electrical appliances and housewares (≃ ISIC 3833)

Capital goods

49 Structural metal products (ISIC 3813)

50 Other metal products, except machinery (the rest of ISIC 381)

51 Non-electrical machinery and equipment (= ISIC 382)

52 Electrical machinery and appliances

54 Electronic equipment and apparatus

55 Electrical equipment and appliances

Groups 52, 54 and 55 are sometimes put together under the title Electrical Machinery and Equipment (ISIC 383).

56 Automobiles

57 Coachwork, engines and automobile parts

58 Transport equipment and materials

Groups 56, 57 and 58 are sometimes put together under the heading Transport Equipment (ISIC 384).

Within group 51 there are eight subgroups (510-518), among which we observe:

1. Subgroup 511 Industrial machinery and equipment, of which subdivision 5111 Woodworking and metalworking machinery (≃ ISIC 3823) includes machine tools. In the inventories this subdivision corresponded to:

3616 in 1960

3621 in 1970

3620 in 1975

and in the current Mexican Classification of Economic Activities and Products (CMAP), to 382102 Manufacture, assembly and repair of woodworking and metalworking machinery and equipment (subdivision of 3821 Manufacture and repair of machinery and equipment for specific purposes, with or without electric motors, including agricultural machinery).

2. Subgroup 512 and its subdivision 5121 Office, computing and accounting machinery (≃ ISIC 3825) corresponded to:

3614 in 1960

3641 in 1970

3640 in 1975

and in the new CMAP to 382301 Manufacture, assembly and repair of office machinery (subdivision of 3823 Manufacture of office, computing and data processing machinery, which also includes weighing apparatus and instruments).

In the ISIC, for the engineering industries there is still under 38:

apart from: 381 Metal products except machinery and equipment

382 Non-electrical machinery

383 Electrical machinery

384 Transport equipment,

the group: 385 Scientific and professional measurement, control, photographic and optical equipment.

For international trade

SITC for the Engineering industries

7 Machinery and transport equipment:

71 Generating machinery and equipment

72 Specialized machinery for certain industries

73 Metalworking machinery, of which 736 is Machine Tools

74 General industrial machinery and equipment

75 Office machinery and automatic data processing equipment

76 Apparatus and equipment for telecommunications, recording and sound reproduction

77 Electrical instruments, appliances and machinery

78 Road vehicles

79 Other transport equipment

8 Various manufactured articles:

87 Professional and scientific measuring and monitoring apparatus and instruments

88 Photographic apparatus, equipment, supplies and optical products, clocks and watches

CHAPTER I. CHARACTERISTICS OF THE MEXICAN MACHINE TOOL INDUSTRY

1. Overall data on the sector

1.1 Definitions

The machine tools referred to here are those used to work metals (and not wood or plastic materials); they are conventionally subdivided into two major categories, first those which cut metal, and, second, those which shape or form it. In world production in terms of value, the former account for about 80 per cent of the total. The following outline gives an overall view.

MACHINE TOOLS

For working metals		For working wood and plastic materials
Metal-cutting MT	Metal-forming MT	
- lathes	- presses	
- milling machines	- benders	
- drilling machines	- rollers	
- grinding machines	- shearing machines	
- machining centres		

Here we are interested basically in the most important metal-cutting machine tools. They can be rearranged into less than a dozen categories, although they are in fact very numerous: there are more than 3,000 different types according to size, mode of operation, possible combination of operations, and size or shape of the parts that they can machine. Further on we will define four main categories. At the end of this section there is a mini-French-Spanish-English glossary showing the main terms used and illustrating some of them.

(a) Lathes and jig-boring machines

Lathes are the machine tools that are most frequently employed. They turn a part around an axis formed by a straight line passing through the two points where it is gripped, and the tools needed for making cuts of different depths and by operating at a variable distance from the ends of the part along this axis, impart different shapes to it. The movement of the tools, the depth of the cut and so on is a step-by-step process or it can be arranged in advance in the case of the most highly automated lathes.

(b) Milling machines

While lathes shape the outer configuration of a part or a solid, milling machines shape the inside by means of drills. The term "to mill" means to widen the orifice of a hole.

(c) Drilling and boring machines

Drilling machines are the basic tool used by the domestic handyman, but they are also a basic machine tool. When starting with a machined (turned) solid, the milling operation may first require drilling. Industrial drills are of different types, for example the pillar type.

Boring involves polishing and imparting an exact diameter to the inside of a tube or to a hole.

(d) Grinding machines

The working of metals entails not only giving them a particular shape inside or outside but also the manufacturing of parts which can fit together, or sometimes work together, with increasing requirements as regards precision. Grinding machines are intended to supplement, whenever necessary, the work of other machinery.

(e) Planing, shaping and mortising machines

Planing and shaping machines have the same purpose, i.e. they are intended to cut successive layers of metal from the same surface, which is plain in the case of the former. The mortise is a hollow notch in a part into which the tenon of another part is usually made to fit during assembly.

(f) Electro-spark erosion, laser-cutting and electro-chemical cutting machines

Although the above machines are in effect of the same type as those used for woodworking, and although their development for metalworking dates from the beginning of the 19th century, progress has led not only to improve them - more power, faster operation, greater efficiency, greater precision - but also to attempts to replace them. The metal-cutting process has thus gone beyond improvements in the quality of tools - use of tungsten carbide and, more recently, ceramics - to the use of electronic engineering. For example, some machines use electrodes, electron beams or lasers for working metals. They are what are known generally as unconventional machines, and are used, among other things, for the machining of special alloys.

(g) Machining centres

Another form of progress has been to combine several types of machine tools in one machine and at one work station, thereby making it possible to machine parts on several axes and thereby turn, drill, bore, mill or grind one and the same part.

(h) Numerically controlled machine tools

The most important progress has related to the way in which the machine tool is controlled. In the past, the operator controlled the machining of the part bit by bit. In order to make the series of parts to be machined uniform, the operator manufactured a standard piece which was fairly easy to copy with the machine. Templates thus came into use and in the same way systems were developed to machine parts by copying the templates. Using different arrest systems it was possible, furthermore, to make the machines work on a semi-automatic basis.

There was a decisive step forward when it became possible to record in advance the movement of the tool, or relative to the tool and the part, and to make the machine repeat it automatically as soon as the part to be worked was fixed in it. This progress was accompanied by calculation of the most efficient movements and by the recording of them in the form of coded instructions. The numerical coding was first recorded on perforated tape; once the tape had been made, it ensured a type of machining for a given part that the machine could carry out by itself, once the part had been properly fixed to it and it was set going. This is called a numerically controlled machine.

Progress in electronics and data processing afforded these numerically controlled machines, which were still only just beginning in the 1960s, an opportunity for much greater flexibility. If a computer is coupled to a numerically controlled machine tool, the latter can be given instructions relating to the choice of tool, its orientation, the speed of operation, replacement of the tool, depth of cut and so on, no longer by a perforated tape recorded once and for all (or for a long time), but by a program in the computer memory. It is clear that the program can be rapidly changed and that the computer memory can contain a large number of programs. In actual fact, the range of variation in the control of the machine tool then becomes infinite and almost instantly available. We now speak of CNC (computer numerically-controlled) machine tools.

There has been further progress at the level of the workshops, i.e. sets of machines, and even at the level of the enterprise as a whole and the design offices for purchase and sales services. In the workshops, the management of production and the machining of a part may require it to pass through several machining centres and/or individual machines, and it could be of value for all the operations to be properly co-ordinated. In a case when a set of machine tools is connected to the same central computer, we speak of direct numerical control (DNC). Nowadays there is ever greater preference for co-ordinating these machines and establishing a dialogue between them, using their own computers, in which case the set of machines becomes a sort of flexible workshop which is almost at the stage where moving the parts from one workplace to another and loading and unloading them on the machires could also be automated.

Within the enterprise as a whole, the research and development offices are now starting to design parts with the aid of data-processing stations, which is known as computer-aided design (CAD); they also have in mind industrial manufacture in a similar manner, i.e. CAM (computer-aided design and manufacture). Whatever the exact computer-aided manufacturing process may be, the aim is to try to co-ordinate the whole operation in the most efficient manner possible with the aid of data processing. Hence people now speak of CIM (computer-integrated manufacture).

During the 1970s, programmable numerically-controlled machine tools gradually became widespread, especially as far as lathes were concerned. It is only since the middle of the 1980s that the CAD/CAM and CIM systems have been increasing in number. Both types are installed in production areas where they make for considerable gains in productivity: this fact is boosting their popularity and encouraging reconstruction permitting their use.

1.2 Production and trade

The production of machine tools in Mexico is relatively poor compared with the size of the Mexican industry. For example, in 1986, Mexican production was reported as $18 million - which is certainly lower than that of 1981 ($24 million), but it only represented at that time less than a twentieth of the Brazilian production ($370 million). This 1 to 20 ratio cannot be compared with the ratio of the manufacturing value added. The latter, despite the already mentioned differences in comparison due to fluctuations in the exchange rate and high inflation, is at a clearly lower level which varies between 1 to 2 and 1 to 3. 4/

4/ If, for example, we take the World Bank data in the reports for 1988 and 1989, respectively, we find for 1986 a ratio of 1 to 1.6 ($49,584 million as against $80,632 million) and for 1987 a ratio of 1 to 2.4 ($48,260 as against $113,707).

Estimated machine tool production and trade in Mexico
(in millions of dollars)

	Total	Production of which metal cutting	forming	Consumption	Exports	Imports
1977	6.0	5.0	1.0	86.0	0.3	80.0
1978	13.6	9.5	3.1	87.3	1.3	75.0
1979	15.5	nd	nd	99.0	1.5	85.0
1981	24.0	12.0	12.0	470.0	4.0	450.0
1982	18.0	nd	nd	216.0	2.0	200.0
1983	21.0	nd	nd	69.0	2.0	50.0
1985	18.0	nd	nd	161.0	3.0	146.0
1986	18.0	15.0	3.0	216.0	1.0	199.0

Note: According to the sources, the demand or imports for the years 1974-1976 varied by twice as much: from $80-100 million to $190-245 million. The World Bank (1979) and, on occasion, UNIDO (1985) have reproduced the high estimate, which seems surprising. The fact is that many authors have relied on the American Machinist for February, but this source is not very reliable in the long run for Mexico. NAFINSA itself (1985) challenges the figures given for 1983, which it nevertheless reproduces in its publications. In any case, there is no agreement with the national export and import statistics, and the difference seems to go beyond problems of f.o.b. and c.a.f. The data here are those reported in the sources in our reference list when they are based on the American Machinist.

Machine tool production was already considered poor some 10 years ago (World Bank, 1979). Although growth was strong, observers were intrigued by the fact that countries like India, Spain or Brazil were increasing production while Mexico was at a standstill. Whatever the fluctuations in the figures for currency in the table above, which reproduces the data from the American Machinist, the level of Mexican production remains extremely low. The production is clearly lacking in variety: the lathes produced are the most simple and conventional type; there are no borers, no radial drilling machines or any gear-cutting machines, and hardly any planing machines. Clearly, there was no production at all of non-conventional machines or numerically-controlled machines.

Leaving aside the most simple conventional lathes, the most sophisticated production is accounted for by several types of milling machines. It has progressed as follows in terms of number of units.

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989*
Number of milling machines	108	264	238	235	254	280	327	160	324	246

Source: Ministerial data.

* Forecasts for 1989.

The trend shown is certainly not that of a type of production that is increasing steeply at the stage of initiation. Clearly, the production of machine tools has not yet got going in Mexico, although for more than 10 years the analysts have believed that it might be possible, especially in view of a relatively big domestic market.

The table on page 21 shows in effect that the Mexican market requirements are essentially met by imports, with exports being considered as negligible as far as the absolute amounts and their ratio to the domestic market are concerned. This market, moreover, has an importance which is fully in line with the size of the Mexican industrial apparatus. If we take up again the previous comparison with Brazil, we see, for example, that for 1986 the ratio between the Mexican and the Brazilian markets was 1:1.8. 5/

Hence Mexico is in the ususual position of a relatively industrialized country and, as a result, a relatively big consumer, yet with extremely low production. The following shows the distribution of the Mexican machine tool imports for the last three years. This time the data are taken from the Directorate General for Foreign Trade (the figures do not agree with the estimates in the American Machinisc).

5/ Or $379 million for the Brazilian market.

Imports of metal-cutting and forming machine tools
(in thousands of current dollars)

		1986	1987	1988
1.	Machining centres	28 617	20 512	25 331
2.	Lathes, including numerically-controlled machines	16 819 9 952	12 314 7 753	24 067 14 085
3.	Drilling, boring and milling machines, including numerically-controlled milling machine tools	8 756 627 2 828	8 667 907 2 441	13 373 1 583 3 571
4.	Grinding and other finishing machines, including numerically-controlled machines	17 875 407	18 597 367	23 600 540
5.	Shaping, planing and mortising machines	4 625	3 437	6 018
6.	Various machines including electro-spark erosion machines	5 076	3 405	5 807
A.	Total for metal-cutting machines (1+2+3+4+5+6), including numerically-controlled machines and machining centres	81 768 41 804	66 732 31 073	98 196 41 537
B.	Forming machines	52 744	39 189	63 991
Total imports (A+B)		134 612	105 921	162 187

Source: GERDIC calculations based on SECOFI data, Foreign Trade Secretariat; Director-General for Foreign Trade Policy, state as of 25 September 1989.

Note: These data are border-line values classed according to the new nomenclature in use (NIMEXE of the EEC). For forming machines we have the sum of the items 8462, 8463, 8464, 8465 and 8466. For metal-cutting machines line 6 corresponds to 8456, line 1 to 8457, line 2 to 8458, line 3 to 8459, line 4 to 8460, and line 5 to 8461. Within each item a special aggregate has been made to indicate the numerically-controlled machine tools.

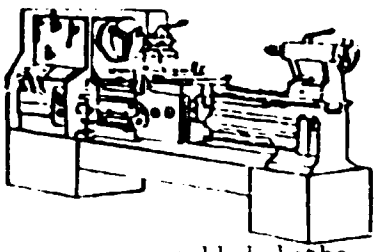
We see first that 60 per cent of the machine tools imported are metal-cutting machines. Then we note that within this group, the numerically-controlled machine tools and the machining centres today account for 40-50 per cent of the total imports. All categories of machines are imported and lathes represent the primary category, a little bit in front of grinders. This is certainly due to the fact that the former are made locally, which does not apply to the latter.

Simultaneously, we see that 60 per cent of the imported lathes are numerically-controlled machines that are not manufactured locally. In similar fashion we observe a relatively modest import of milling machines, which are the basis of domestic manufacture, other than forming machines.

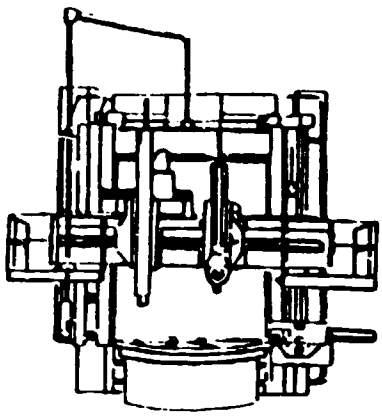
Consideration of the data for production and trade shows that today, just as 10 years ago, the Mexican industry offers a vast market for machine tool producers, but that the latter have not been able to find their place in it, and that although the market is following the world trend towards numerically-controlled machines and machining centres, local production is totally lacking in this dynamic trend. Indeed, conditions for opening the market to imports have always been favourable for foreign competition and today the importation is free, with customs duties ranging between 10 and 20 per cent, according to the item, but it is not certain whether the competitiveness of prices is the basic problem which producers have had to face.

Mini-glossary of machine-tool terms

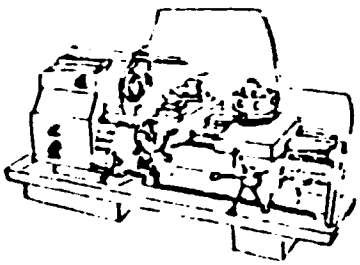
Français	Espagnol	Anglais
- Machines outils (MO)	- Máquinas herramientas (MH)	- Machine tools (MT)
- MO travaillant par formage	- MH de deformación	- Forming MT
- MO travaillant par enlèvement de métal, de copeaux	- MH de corte, por arranque de viruta	- Metal cutting MT
- Tours	- Tornos	- Lathes, turning M
- Machines à pointer	- Máquinas de apuntar	- Jig-boring M
- Fraiseuses	- Fresadoras	- Milling M
- Machines à percer, perceuses	- Máquinas de taladrar, taladros	- Drilling M
- Machines à fileter	- Máquinas roscadoras	- Threading M
- Machines à tarauder	- Máquinas de roscar	- Tapping M
- Machines à aléser, aléseuses	- Máquinas de mandrillar, mandriladoras (o mandrinadoras)	- Boring M
- Machines à rectifier, rectifieuses	- Máquinas de rectificar,	- Grinding M
- Raboteuses (rabots)	- Cepilladoras (cepillos)	- Planing M
Etaux-limeurs	- Tornos de limar	- Shapers
- Mortaiseuses	- Mortajadoras	- Mortising M
- Centres d'usinage	- Centros de maquinado o de mecanización	- Machining centres
- Machines d'usinage par électroérosion à électrodes	- Máquinas para mecanización por electroerosión de electrodo	- Electro-spark erosion machining appliances
- Machines d'usinage par faisceaux d'électron, par laser	- Máquinas de macanización por haces de electrones, por láser	- Machines using electron beams, laser machining
- Broche	- Husillo	- Spindle
- Engrenages	- Engranajes (o engranes)	- Gear
- MO à commande numérique (MOCN)	- MH de control numérico (MHCN)	- Numerically controlled MT (NCMT)



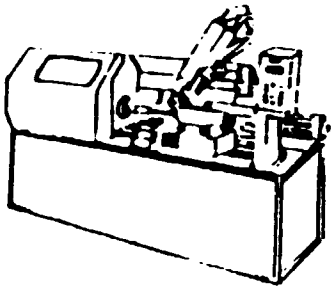
All-purpose parallel lathe



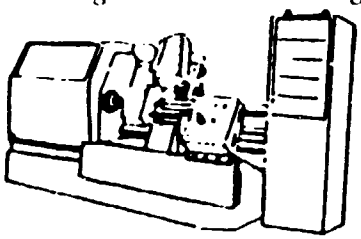
Vertical lathe



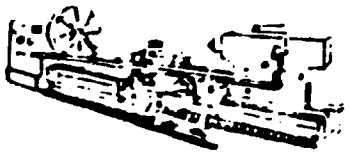
Turret lathe



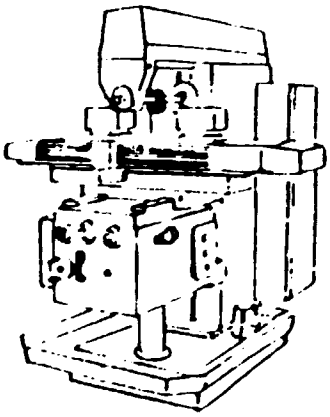
Tracing lathe with swing



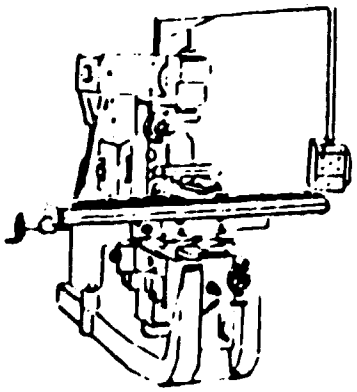
Chucking lathe



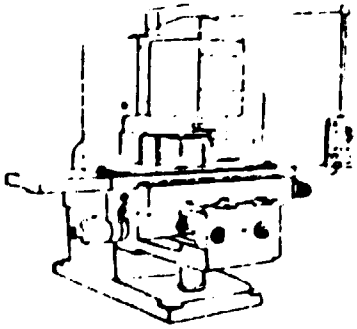
Large-size lathe



Horizontal milling machine

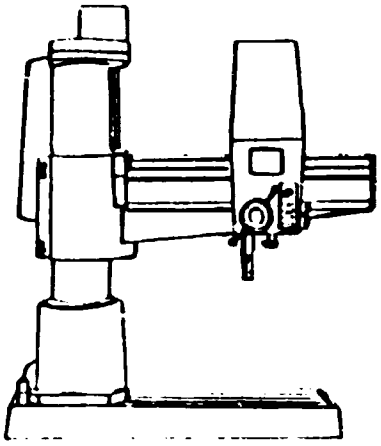


All-purpose milling machine

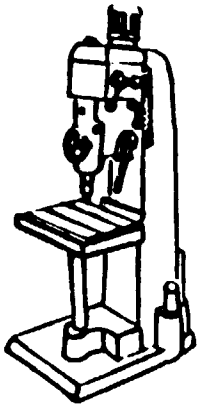


Vertical milling machine

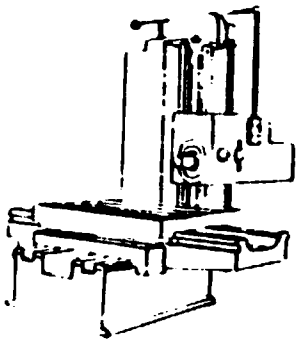
Source: According to NAFIN, 1987



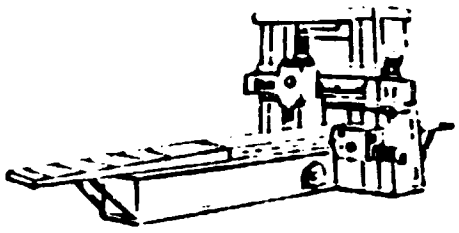
Radial drilling machine



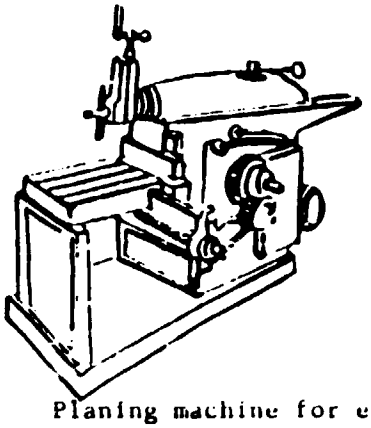
Pillar drilling machine



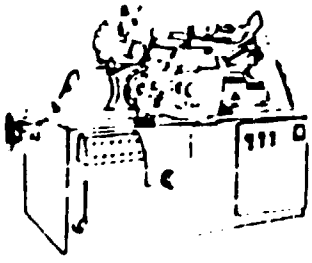
Driller



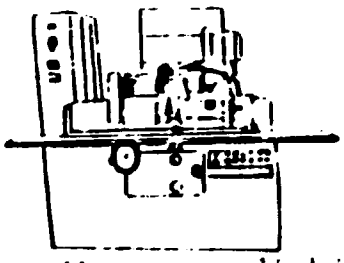
Planing-milling machine



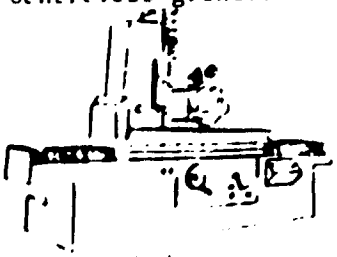
Planing machine for elbows



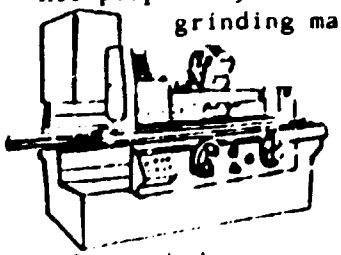
Centreless grinder



All-purpose cylindrical grinding machine

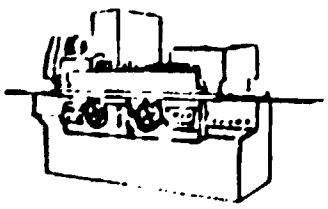


Plane grinder

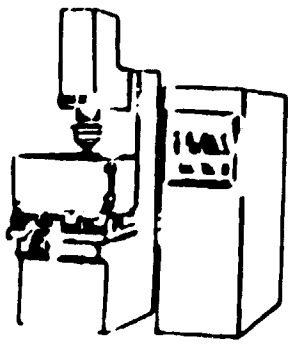


Bar grinder

Crank grinder



Cylinder grinder



Electro-spark erosion machine

2. Progress and structure of the industrial tissue 6/

2.1 Background

The development of the industrial fabric of Mexican machine-tool producers, more especially metal-cutting machine tools, is typically a regressive trend which nothing seems to be able to stop.

In 1966, the whole of the machine tool industry comprised some 30 enterprises, the turnover of which was estimated at about 200 million pesos in 1980, or about 10 million 1980 dollars. That production covered 7 per cent of the total demand, excluding special machines intended for the car industry. In 1973, there were only 15 enterprises left, of which the overall turnover in 1980 pesos was of the order of 10 million 1980 dollars. That production covered about 8 per cent of the total demand. According to a production study made in 1975 by the World Bank (1979), the principal purchaser was then a public body called CAPFCE, which purchased equipment for schools and training centres. The public authorities seemed at that time to be interested in the sector and, via public enterprises, set up the manufacturers: Fanamher in 1975, and then MECAMEX, which assembed imported lathes. Nacional Financiera, the Mexican investment bank, in association with UNIDO, has been studying the capital goods sector and ways and means of ensuring its promotion since the middle of 1970s.

The balance published by that organization in 1985 is relatively optimistic since, although the number of enterprises was slightly lower - there were 13, of which 7 made metal-cutting machines - the assessed production for 1980 attained 600 million pesos, or more than double the figure for 1980. For the sector as a whole, this balance indicates that 58 per cent of the enterprises are semi-public concerns. On pages 29 and 30 there is a table showing a list of all the producers and the nature of their products in 1980.

Since 1980 the situation appears to have developed in a very adverse manner. Of the seven producers in existence in 1980 there were only two firms left by 1989 (Nos. 2 and 7 on the list), who are joined by two others, one set up in 1982 and the other in 1987. The total employment available is 295 persons for all four enterprises (see the table on page 31).

We have been able to glean some information on the firms which disappeared during the 1980s as well as on the firms presently in operation.

6/ This section is based on previous work by NAFINSA-UNIDO published between 1977 and 1987. See the bibliographical references of the end of the report.

National machine-tool producers

Firms	Products	Products structure in 1980
TOTAL		100.0
A. Removal of chips	SUBTOTAL	65.4
(1) Empac-O-Matic, S.A.	(a) Sharpeners with grindstone diameter 125-175 mm	0.5
(2) Fabrica de Maquinas y Accesorios, S.A. de C.V. (FAMA, S.A)	(a) All-purpose parallel lathes with swing of 390-700 mm and length of 1000-2000 mm	9.7
(3) Fabrica Nacional de Maquinas-Herramienta, S.A. de C.V. (FANAMHER)	(a) All-purpose parallel lathes with swing of 320-500 mm and length of 1000-2500 mm	
	(b) Plane grinders with table 475 x 175 mm	
	(c) All-purpose milling machine with tables 240-300 x 1100 mm	
	(d) Pillar drilling machines with bits 32-75 mm in diameter	23.6
(4) Industrial Lagunera, S.A. de C.V. (ILSA)	(a) Elbow planers with 320-370 mm travel swing	
	(b) All-purpose parallel lathes with swing of 368-450 mm and length 750-2000 mm	12.2
(5) Mecanica Mexicana de Precisión, S.A. (MECAMEX, S.A.)	(a) All-purpose parallel lathes with swing of 450 mm and length 1000-2000 mm	4.7
(6) Mecanomex, S.A.	(a) Alternative source with maximum cut of 230 mm round and 180 mm square	1.1
(7) Oerlikon Italiana de México, S.A. de C.V.	(a) All-purpose milling machine with table 280-330 x 1300-1800 mm	
	(b) Vertical milling machine with table 330-400 x 1300-1800 mm	
	(c) Horizontal milling machine with table 330-400 x 1300-1800 mm	13.6

Firms	Products	Products structure in 1980
B. Deformation	SUBTOTAL	34.6
(1) Dreiss and Krump de México, S.A.	(a) Mechanical benders 0.76-4.75 m long and force 15-400 t	
	(b) Mechanical shears 1.32-3.04 m long and cutting thickness 1.5-3.4 mm	
	(c) Hydraulic shears 1.82-3.40 m long and cutting thickness 6.16 mm	14.6
(2) Fundición y Talleres Anahuac, S.A.	(a) All-purpose mechanical shears for bars and profiles, with thicknesses up to 65 mm	0.8
(3) Hidromex, S.A. de C.V.	(a) Hydraulic presses 1.8-3.4 m long and cutting thickness 6-12 mm	3.4
(4) Industria Automotriz, S.A.	(a) Mechanical presses with force of 22-200 t	3.5
(5) Máquinas Mexicanas, S.A.	(a) Hydraulic presses with force of 5-250 t	5.6
(6) Máquinas Monterrey, S.A.	(a) Mechanical benders 1.25-3.75 m long and force of 60-450 t	
	(b) Mechanical shears 1.25-3.75 m long and cutting thickness 6-12 mm	6.7

Source: NAFINSA/UNIDO Capital Goods Joint Projects - NAFINSA (1985), p. 140.

Lathe and milling machine manufacturing industry

Enterprise (Product)	Production 1986	1987 Units/Value	1988	1989 (Preliminary)	Present direct employment	Present Direct investment in fixed assets*	Social capital and structure*	Technology	Average degree of integration (% C.P.)
CORMETAL, S.A. DE C.V.				(Sept.)	12	1 757	751 51% domestic	Bulgaria	
Lathes	--	155/845	180/4980	120/4200					40
Milling machines	--	--	12/617.6	8/530.6					32
Computerized numerical controlled machines	--	--	3/624	2/583					48
OERLIKON ITALIANA DE MEXICO, S.A.				(Oct.)	85	9 123	2 236 98.5% domestic	Spain Italy	
Lathes	200/1026	232/358	24/72	33/155					100
Milling machines	280/1077	104/697	188/1478	104/2200					96
FABRICA DE MAQUINAS Y ACCESORIOS, S.A. DE C.V.				(Oct.)	85	9 676	9 831 99.8% foreign	Czechoslovakia	
Lathes	93/281	126/681	253/4080	285/4500					48
Milling machines	47/200	56/238	124/1920	71/1500					43
INDUSTRIAS CASTRO, S.A. DE C.V.					112	300	70 100% domestic	Mexican	
Lathes a/	200/500	250/880	300/1672	--					100

Source: SECOFI, Secretariat for Industry and Foreign Investment, General Directorate for Industrial Development, Sub-directorate for the Capital Goods Industry.

* Millions of pesos.

a/ The figures for this enterprise are projections provided in the year 1986, as a result of which the record of it in the promotion programme has not been reassessed since that year, meaning that these amounts will have to be taken with certain reservations.

2.2 Firms which have disappeared since 1980

Starting with the list contained in the table on pages 29 and 30, let us take first the case of the enterprise Industrial Lagunera (No. 4). In 1980 this concern was the oldest one manufacturing machine tools (since 1964). However, first and foremost, it was manufacturing pumps. The World Bank report for 1979 (op. cit.) pointed out that its costs were double the world price. It is probable that the broader opening of the frontiers and the drop in public demand were impossible for it to overcome. The case of MACAMEX, which was 80 per cent public, is of the same type although it was already pointed out in 1979 (ibid.) that the firm was suffering from financial constraints. We have no information either on MECANOMEX or on EMPAC-O-MATIC, which both disappeared, but which only had very small production: less than 5 per cent of the Mexican machine tool production for metal-cutting tools. Conversely, it is interesting to look into the case of FANAMHER, a public enterprise which was alone responsible for more than two thirds of the production of these machines in Mexico.

FANAMHER was set up in 1973 by the iron and steel industry group Altos Hornos de Mexico (AHMSA) (which had itself been merged with the publicly-owned iron and steel in SIDERMEX) and had commenced activities in 1975, with the benefit of two increases in capital (in 1978 and 1982). In 1986 it was privatized and left the semi-public group. Three years later it went broke and disappeared. Various opinions obtained from AHMSA, some of its clients, its competitors and also from the Ministry of Industry, all agree that the products sold by FANAMHER were good. Nevertheless, they were not sold - or saleable - at high enough prices to ensure a satisfactory cash flow. Its clientele was limited and its development was based on reproduction of a number of products (six types of lathes) with licences of different origin (Italy, Spain, Yugoslavia), without any genuine attempt to gain more thorough technological mastery of machines which, even so, were highly traditional. Under these operating conditions the enterprise remained very fragile and sensitive to the least difficulty, in particular fluctuations in demand, and to the increase in local competition. As a result, FANAMHER could not survive.

2.3 Firms in operation in 1989

Industrias de Castro was set up in 1982 and has been manufacturing lathes for schools and training centres. It employs 112 persons, given a productivity which in terms of value is almost the fifth of that of the main Mexican lathe producer. This firm has, it would seem, a small reserved market for lathes that are not very efficient and are turned out with its own technology.

Cormetal employs 12 persons for production purposes with a relatively high turnover. It is a firm with Bulgarian capital that makes small lathes and small milling machines based on Bulgarian technology. It remains in contact with Bulgaria where it exports some of its products. The total production is about 100 lathes, a few milling machines and two numerically-controlled machine tools, about which no one knows very much. The degree of integration of the production seems to be low and eventually the assembly operations may be switched to something else.

Oerlikon Italiana de Mexico SA is one of the two oldest enterprises. 7/ It has so far been the biggest Mexican producer of milling machines. Originally, it worked under licence from Oerlikon Italiana de Mexico, but in the mean time it has,

---

7/ According to 1959 and 1976 sources.

according to its own statements, come into possession of its own technology. The Ministry of Industry considers, however, that it manufactures products with Italian and Spanish technology. Up until 1988 it had the benefit of public subsidies, which later stopped. Furthermore, we have learnt that NAFIN possessed 50 per cent of its capital, but that it had to withdraw from it and then privatize Oerlikon. The enterprise is reported to have sold its equipment to (foreign) car companies, as well as to industrial engineering firms. The Ministry considers that the market is currently very difficult, with clients who invest very little, who have little confidence in the Mexican machine tools: they are thought to be exposed to too much competition by imports. In order to survive it seems essential to launch a major project for the complete renewal of investments. It should be noted, in particular, that at the present time, despite its stock of 25 machine tools, there is no numerically-controlled machine. An investment of that kind would be the only way in which it could produce at costs competing with the price and grade of imported machines. That, too, seems to be a condition for survival.

FAMA is a private enterprise set up in 1968, 8/ with the aid of Czechoslovak capital, but with 51 per cent Mexican capital up to 1987. Since that date the capital has been 88 per cent Czech, 43 per cent from a bank, and 49 per cent from Strojimport. Up until 1983, according to its director, the enterprise made its way, after which thanks to new equipment it began to expand. It manufactures Czech lathes and milling machines, but for which it has no licence since the technology is obsolete. The equipment appears to be fairly good (about 50 machine tools) and a little bit more modern than that of other enterprises. The company has, among other things, a numerically-controlled machining centre and a numerically-controlled grinding machine. This is basically the Czech type of equipment. According to the firm, it sells products that are not in competition with the products of the industrialized countries, but compete against machines coming from Brazil, South Korea, Taiwan and Singapore, by which it feels challenged in terms of price and quality. Its clientele is made up of 80 per cent of small- and medium-size engineering shops. The rest is the automobile industry, but not for manufacturing processes: it has sold to a Volkswagen prototype workshop and to a Ford maintenance shop. Indeed, it seems that FAMA, with better equipment than the other producers, has competed with them on the market less exposed to competition from imports without having bitten into it and without being sure that the market is developing or even continuing to be sheltered. FAMA, in fact, is considering the production of numerically-controlled machines, and a lathe and milling machine based on existing equipment, for which the numerical control will be imported. There again, it seems that a project of this kind is essential if the firm is to survive within the context of a policy exposing it to international competition.

3. Production processes and technology

The production processes employed are those of machinery of which the design is usually very old. According to NAFINSA (1987, p. 123): the designs of the machine tools produced in Mexico are slightly modified versions of those produced some 25 or 30 years ago in the countries of origin. Management of the production process is highly traditional, without using data processing. Generally speaking, both in the metal-cutting machine sector and metal-forming sector, companies have acquired the basic and detailed engineering needed for production and do not have personnel engaged in the design or development of new machinery. Although a certain know-how has been acquired, it relates to practices based on older technologies without a true transition to a technological mastery which, furthermore, would require the proximity of more sophisticated production equipment.

8/ 1963 or even 1968, according to the sources.

For the whole of the machine tool sector in the broader sense (NAFINSA, 1987), the average cost structure is as follows:

Raw materials and national components	35 per cent
Raw materials and imported components	24 per cent
Manpower	29 per cent
Energy and fuel	6 per cent
Other direct costs	6 per cent
Total	100 per cent

Generally speaking, producers suffer from a certain disadvantage associated with the relatively high price of steel: for example, $625 per ton, in weighted prices, as against $425 in the United States (NAFINSA, p. 561), or else an excess cost of nearly 50 per cent. To that is added the fact that in the case of potential high-grade production the special steels and alloys, and the electrical and electronic components would have to be imported. This is not offset by the advantage of direct manpower costs. This advantage seems in fact not to have withstood the fact that in the case of the simplest types of production where this relatively unskilled manpower can be used, automation, even though partial, of the production lines yields large productivity gains. Conversely, if we wish to go on to more elaborate forms of production, we have to recruit a clearly higher level of skilled manpower. At the present time, for all the enterprises manufacturing metal-cutting machine tools, there are only 10 or so engineers, since the technical staff is only at the technician level (baccalaureate).

It is hardly likely that this kind of potential could move the Mexican machine tool production forward.

Local provision of components is hardly developed, and most of the firms import or produce them. However, there are several enterprises manufacturing tools, such as UTEMEX. Actually, the tools made by this enterprise are chiefly intended for woodworking machine tools that call for greater precision. The firm, however, has a certain know-how that it has, furthermore, patented, and it is seeking to imitate the technologies and products coming from abroad. Mexican steel is not good enough for its needs and it has to import almost half of what it requires. It stocks up mainly in Mexico with tungsten carbide (which Mexico produces), except for the highest quality which it has to import from Japan.

The integration rate seems, nevertheless, to be high (see the table on p. 31): almost 100 per cent for Oerlikon, although the enterprise told us that 35 per cent of its production cost was accounted for by imported items. Similarly, NAFINSA, 1987 (p. 123) indicates that the gearbox and apron of the lathes are imported. Thus, as often happens, there is reason to be wary of the rates calculated from complex formulae. The enterprise considers that it is more highly integrated in terms of the smaller lathes and milling machines. A higher integration rate cannot be attained unless there is vertical integration in the present state of the industrial fabric.

In view of the relatively large local market, it is surprising that there has never been any modern foreign investment of the direct kind, nor any technology transfer.

Globally, Mexico receives foreign technologies, more especially for the manufacturing industry, and the contracts are recorded by the public authorities. 9/ Between 1983 and 1988, the average annual number of contracts was 400, 35 per cent of which related to the metal products and machinery and equipment branch. 10/ The chief types of contract covered technical assistance and transfer of know-how. Within that branch, according to the new classification, two sub-divisions have to be crossed before reaching the machine tools, 11/ where we find all in all 15 technology transfer contracts between 1983 and 1988, the details of which are shown in the table below. It can be seen that some of them are accompanied by more job opportunities, which is usually the case when there is direct investment. These cases do not relate to the production of metal-cutting machine tools.

The technological situation is therefore alarming, all the more in that it seems normally impossible not to follow the path of gradually acquiring technologies that are more and more complicated. According to some analysts, machine tools can be arranged in three groups of growing complexity (see the table on page 37). While many countries in the third world have already developed a sound foundation in group 2, and although some of them have already entered into the productions in group 3, Mexico has yet to consolidate its experience in group 1 in order to make a proper entry into group 2.

9/ The new law dated May 1987: "Law governing the control and registration of technology transfer and the use and exploitation of patents and trade marks and their regulation". This is enacted by the Secretariat of State for the Regulation of Foreign Investments and Technology Transfers of the Ministry of Trade and Industrial Development (SECOFI).

10/ Source: Our calculations are based on data from the Directorate General for Technology Transfer, October 1989; in terms of branch, this is Division VIII (see nomenclature annex in the introduction).

11/ 3821, machine tools for specific purposes, of which 381102 relates to woodworking and metalworking machinery.

Contracts for technology transfer between foreign countries and Mexico

In the branches: manufacture, assembly and repair of woodworking and metalworking machinery and equipment (branch 382102, CMAEP)

1988		
	United States (5/88 - 5/98)	Transfer of technical know-how and technical assistance
		Production and processing technologies free of cost
1986		
	United States (10/85 - 12/99)	Assistance or advisory services on enterprise administration
	United States (5/86 - 12/99)	Assistance and transfer, as well as granting of trade marks with the creation of 314 jobs
	United States (11/85 - 12/87)	Technical assistance and transfer
	United States (6/86 - 6/93)	Technical assistance and transfer
	Spain (1/86 - 12/99)	Granting of trade mark free of cost
1985		
	United States (9/84 - 10/84)	Technical assistance and transfer
	German Democratic Republic (3/85 - 3/90)	Assistance, technology transfer and creation of 275 jobs
1984		
	United States (12/84 - 12/94)	Assistance, technology transfer and creation of 52 jobs
1983		
	Italy (3/83 - 12/99)	Three contracts for the granting of trade marks for a product
	United States (6/83 - 6/93)	Technical assistance and transfer
	Federal Republic of Germany (10/83 - 10/92)	Assistance, technology transfer and granting of trade marks and creation of 408 jobs
	United States (8/88 - 8/98)	Technical assistance

Group 1	Group 2	Group 3
Centre lathes	Turret and automatic lathes	Numerically-controlled machine tools
Bench and pillar, drilling machines	Radial drilling machines	
Simple milling machines	Milling machines	Special-purpose production machines
Small mechanical presses	Grinding machines, boring machines	Transfer machines
Sheet metal-forming machines	Gear hobbing machines, heavy mechanical and hydraulic presses	

Source: World Bank (1979), p. 150.

CHAPTER II. DIFFUSION OF MACHINE TOOLS IN MEXICO

Classification of machine tools by degree of complexity

1. Machine tool park in the capital goods industry

1.1 Domain observed

As far as non-specialized machine tools for a type of machining particular to one type of industry are concerned, their presence will become most important in the upstream industries, known as the capital goods industry. It is this park that we will observe with the aid of the survey published in December 1987 by NAFINSA. The survey dealt with a thousand enterprises interviewed during 1986 and representing fairly exhaustively the capital goods producers. 12/ Some enterprises did not respond to the survey, but their park is modest - this is the case of the producers of electronic and data-processing goods. Conversely, excluded are the car manufacturers who probably make up the first and most modern machine tool park in Mexico. Similarly, the assembly plant industry was not surveyed, although we find there, likewise, an important and modern machine tool park, especially for the production of automobile parts.

The table below shows the distribution of enterprises making capital goods that were interviewed with regard to their machine tool park. We have regrouped them according to the destination of the capital goods which they manufacture with the aid of their park. As an average, there is one machine tool for less than 10 workers, but this average varies between 2.2 for the machine tool industry and 19 for the manufacturers of electrical commodities (generators, transformers, etc.). As a whole these enterprises employ almost 100,000 persons, but they all work with a fairly high degree of under-utilization of their production capacity. As an average, their utilization rate is about 50 per cent and they consider that they could employ 75 per cent more personnel. This does not obviously relate to the capital goods sector, but affects the overall economic situation, first and foremost, as described in the introduction.

12/ For example, for the producers coming under the heading Machine Tool Producers we can find at least one producer making only tools (UTEMEX) and one producer who has disappeared (FANAMHER).

Sectoral distribution of enterprises

Survey of their machine tool park

		Number of enterprises	Employment	Potential employment	Average size at present	Number of jobs per machine tool
1	Intermediate capital goods	261*	23 213	48 656	89	8.4
2	Capital goods for oil, mining, construction and handling	210**	12 495	25 409	60	7.8
3	Equipment for iron and steel, boiler making, forging and casting	114	9 200	20 968***	81	14.9
4	Transport equipment, buses, trucks, railway and aviation equipment	25	6 715	1 400	269	13.4
5	Car parts, diesel motors, coachwork, etc.	99	8 600	21 780	99	9.5
6	Electricity: motors, transformers, components, measuring instruments	137	18 450	42 150	135	19.0
7	Agricultural machinery	21	2 200	4 900	105	6.7
8	Machine tools	30	1 200	1 900	40	2.2
9	Heavy machinery	9	2 300	4 600	256	8.5
10	Equipment for various industries: measurement, paper, textile	43	nd	nd	nd	
11	Equipment for agro-food industry	47	3 000	5 700	47	7.0
12	Equipment for the glass industry	2	1 700	2 300	850	17.9
	Total	998	93 084	161 304	93	9.5

* Of which 62 are enterprises to which the average number of staff of the others has been applied.

** Of which 29 are enterprises to which the average number of staff of the others has been applied.

*** By applying in the case of six enterprises the ratio between total staff employed and the potential staff of the others.

1.2 Data for the whole of the park

The tables on this page give an overall view of the main characteristics of the machine tool park at the disposal of the capital goods industry in Mexico.

Total machine park

Age \ Machines	Lathes	Borers	Planers Shapers	Drillers	Millers	Grinders	Total
0-4 years	641	66	46	534	237	198	1 722
5-9 years	1 199	132	154	886	347	362	3 081
10-19 years	1 206	111	151	939	380	192	2 979
+ 20 years	739	127	98	476	234	258	1 932
Total	3 785	436	449	2 836	1 198	1 010	9 714
%-10 years	49%	45%	45%	50%	49%	55%	49%
%-5 years	17%	15%	10%	19%	20%	20%	18%

Numerically-controlled machine park

Age	Machining centre	Lathes	Millers	Drillers	Borers	Grinders	Total
0-4 years	49	103	30	4	7	8	201
5-9 years	31	61	15	8	11	3	137
10-19 years	9	25	0	32	3	1	70
+20 years	0	0	0	1	0	0	1
Total	89	197	45	45	21	12	409
%-10 years	90%	87%	100%	28%	86%	92%	83%
%-5 years	55%	52%	67%	9%	33%	67%	49%
%-Equipment total	100%	5.2%	3.8%	1.6%	4.8%	1.2%	4.2%*
%-New equipment total (0-4 years)	100%	16%	12.7%	0.7%	10.6%	4.0%	11.3%

* By adding the number of machining centres to the total machine park.

The equipment is relatively sizeable, but old, or even very old. The conventional machinery older than 20 years is greater in quantity than the machinery less than five years old (all categories together).

As an average, more than half the equipment is over 10 years old. Since any machine more than five years old has now been superseded by a machine of a new generation, it can be considered that at least half of the equipment is obsolete.

If we go on to examine the numerically-controlled machine park, we see clearly, first of all, that it is of extremely small size: less than 4.2 per cent of the total park. The numerically-controlled equipment is certainly less obsolete, since 83 per cent of the machines are less than 10 years old and half of them less than five years old. Nevertheless, the transition to using numerically-controlled machines remains extremely limited since within the machine tool park of less than five years the numerically-controlled machines represent only 11 per cent.

The situation, however, may be perceived as an evolutive one. Indeed, we see that the number of machining centres less than five years old is 58 per cent higher than those between five and 10 years old, and that this percentage is 69 for the lathes and even a 100 per cent for the milling machines. But the movement in question is hardly perceptible.

1.3 Sectoral analysis

Detailed information on the park for the 12 sectors that we have formulated is to be found in the annex to this section. Below we give a table summarizing the principal age characteristics of the equipment, how modern it is and its relative place in the sectoral park as against the park as a whole. The values deviating from a normal distribution demand attention and it is these points that we will be discussing. First, they relate to the two most important sectors within which, after examination, we should in each case single out a particularly important subsector. We will then comment on the characteristics of the two sectors which have a specific nature in Mexico. Finally, we will comment on the other sectors whose values deviate from the mean.

Principal sectoral characteristics of the machine tool parks

	Equipment 10 years (%)	NC/total equipment (%)	NC/new equipment (%)	Distribution of the equipment			
				Total (%)	New (%)	NC (%)	New NC (%)
Total	50	4.2	11.3	100	100	100	100
Intermediate CG	52	3.6	10.3	22.5	18.6	19.8	16.9
Various CG	53	5.9	13.4	16.8	15.6	23.7	18.4
Iron and steel	29	1.5	8.3	17.3	14.2	6.3	10.4
Transport equipment	25	1.6	13.3	5.1	2.5	2.0	3.0
Automobile parts	60	4.2	3.8	9.3	22.2	9.5	6.0
Electricity	64	2.7	7.1	9.9	8.0	6.6	5.0
Agricultural machinery	23	6.1	46.6	3.3	0.8	4.9	3.5
Machine tools	71	4.4	4.4	5.5	5.1	5.9	6.0
Heavy machinery	58	9.7	15.4	2.7	2.2	6.3	3.0
Industrial equipment	47	1.4	0.0	2.1	0.9	0.7	0.0
AFI equipment	67	0.7	1.7	4.4	6.6	0.7	1.0
Glass industry equipment	83	57.0	94.6	1.0	3.2	13.2	26.3

CG = Capital goods.

NC = Numerically-controlled.

AFI = Agro-food industries.

(a) Pump manufacturers

The pump manufacturers alone have 41 per cent of the numerically-controlled machines in the intermediate capital goods sector, 12/ or 11 per cent of the equipment of the whole of the capital goods industry. In particular, they have 15 machining centres, i.e. 17 per cent of the total for the machining centres installed in the Mexican capital goods industry (which represents only 4 per cent of the employment).

This industry has a technological level comparable with that of international industry and manufactures in accordance with international standards. This is mainly because the enteprises are basically branches of foreign companies, principally those of the United States, from where they receive the technology and the patents. This also enables the sector to export, despite market prices higher than world prices, with the exports being part of multinational intra-firm trade at internal assignment prices; American companies seemed to find it an advantage for some of the models intended for their market of origin to be made in Mexico. Thus, in 1984, given 12 million imports, the sector only achieved 6 million exports (NAFIN, 1987, p. 39).

(b) Manufacturers of oil-field equipment

As for the preceding subsector, here we are also dealing with a very old industrial sector associated with a market that is largely public. Within the capital goods sector for various industries, this subsector is remarkable for the same reason: the modernness of its equipment. It alone possesses 60 per cent of the numerically-controlled machines in the sector it belongs to, i.e. 16 per cent of the overall equipment of this type belonging to the Mexican capital goods industries. With 47 numerically-controlled lathes, its position is even stronger: it possesses a quarter (24 per cent) of the numercially-controlled lathes of the whole of the Mexican capital goods industry (with less than 2 per cent of the jobs).

The quality of the equipment produced by this industry is essential since its clientele cannot drill oil wells or operate them without risk and in a profitable manner unless the equipment is perfect. Although hard hit by the oil crisis, the firms remaining in operation can survive only if production comes up to international standards of quality. We find there many branches of foreign companies, mainly from the United States, but also companies which have been Mexicanized and have assimilated the technology. 13/

(c) Manufacturers of equipment for the glass industry

In terms of employment, this industry is of the same size as the two previous ones (less than 2 per cent of the total employment in the capital goods industry). It is also a very old one and came into existence in the 1940s. As opposed to the other two, its clientele is not mainly public, but rather private. The Mexican glass industry is one of the most important and most modern industries in the country.

The manufacturers of equipment for this industry are themselves in possession of new and modern equipment which has nothing in common with the performance of the equipment of the other Mexican capital goods industries. Nearly 60 per cent of

---

12/ As we have established on the basis of the data from the survey mentioned.

13/ From NAFIN (1987), p. 71.

their equipment is less than five years old, and nearly 60 per cent is made up of numerically-controlled machines. They alone have 26 per cent of the numerically-controlled machine tools less than five years old in the whole of the Mexican capital goods industry. Their share is still larger (36 per cent): they have more than a third of the machining centres less than five years old (18 centres).

These manufacturers are actually two Mexican enterprises (Fabricación de Máquinas, Monterrey, and Fábrica Nacional de Molduras, Edo de México), which on the basis of foreign licences have mastered the technology and are producing their own innovations with specific designs. They are engaged in geographically extensive export activities (Europe, Asia, Oceania, North and South America) to the extent of 10 per cent of their turnover. They have a large number of qualified staff and carry out research and development. This is the only industry for which the NAFIN study (1987, p. 273) reports the use of the modern production processes CAD/CAM: "extensive use is made of the computer in the production management processes and it is one of the sectors with the broadest experience in design and manufacture using computers (CAD/CAM)".

(d) Manufacturers of equipment for the agro-food industry

This industry is also bound up with a private industry. It covers approximately 90 enterprises, the most important ones of which are connected with foreign companies. They mainly make to order, applying international standards. They export, however, to South America, which is less exacting, and to the United States, probably within the framework of intra-company multinational trade.

Their new equipment is particularly extensive (67 per cent of the equipment is less than 10 years old), showing that this industry has maintained a certain dynamism. Nevertheless, the equipment is not really modern. According to NAFIN (1987, p. 248), this fact is to some extent due to the dispersion of a sector in which the enterprises cannot make a costly investment pay with small volumes of production. The enterprises chiefly make to order, while it would seem that at the international level they manufacture standardized equipment in batches, which permits investment in more modern and more expensive machinery.

(e) Comments on one or two sectors

The preceding table indicates some other values which call for comment.

The manufacturers of agricultural machinery have nearly half of their new equipment in the form of numerically-controlled machines, but this high percentage is not really significant, since the overall equipment is rather old: more than three quarters (77 per cent) is over 10 years old. Basically, the industry makes tractors and combine harvesters within the branches of multinational firms which have not modernized their production processes in Mexico.

The automobile part manufacturers have a great deal of recent conventional equipment (22 per cent of the recent equipment of the capital goods industry as a whole), but their modern equipment is clearly less extensive. Although in the overall sense more than 4 per cent of their equipment is numerically controlled, this relates first and foremost to drilling machines which are more than 10 years of age.

Finally, the manufacturers of machine tools are noted for their high level of equipment per employee (2.2 jobs per machine) and the newness of it (71 per cent of the machinery is less than 10 years old), but here again the equipment is not really modern. The same remarks apply that we made in the preceding chapter and which also hold for the heavy machinery manufacturers.

Sectors	Conventional lathes	Conventional boring machines	Conventional shapers	Conventional drilling machines	Conventional milling machines	Conventional grinders	NC lathes	NC boring machines	NC drilling machines	NC machining centres	NC milling machines	NC grinders	NC Total	TOTAL
ICG	1055	61	100	527	213	168	45	3	6	24	2	1	81	2205
0 - 4 years	145	4	9	68	33	36	26	1	3	6	1	0	34	329
5 - 9 years	345	27	37	205	91	73	21	2	3	17	1	1	45	823
10 - 19 years	471	24	45	217	69	54	1	0	0	1	0	0	2	882
• 20 years	94	6	9	37	20	5	0	0	0	0	0	0	0	171
Various CG	608	46	78	499	186	130	67	6	3	15	5	1	97	1644
0 - 4 years	79	10	5	86	34	26	24	1	0	9	2	1	37	277
5 - 9 years	228	15	18	198	52	57	25	3	1	1	3	0	33	601
10 - 19 years	177	11	31	167	74	27	18	2	2	5	0	0	27	514
• 20 years	124	10	24	48	26	20	0	0	0	0	0	0	0	252
Iron and steel	612	130	48	421	181	282	20	0	0	6	0	0	26	1700
0 - 4 years	105	6	7	61	26	26	17	0	0	4	0	0	21	252
5 - 9 years	61	11	5	88	15	54	1	0	0	2	0	0	3	237
10 - 19 years	181	24	15	108	56	37	2	0	0	0	0	0	2	423
• 20 years	265	89	21	164	84	165	0	0	0	0	0	0	0	788
Transport equipment	141	7	31	184	83	48	4	0	2	0	2	0	8	502
0 - 4 years	10	0	6	12	10	1	4	0	0	0	2	0	6	45
5 - 9 years	26	0	5	21	17	10	0	0	0	0	0	0	0	79
10 - 19 years	22	1	1	58	15	6	0	0	2	0	0	0	2	105
• 20 years	83	6	19	93	41	31	0	0	0	0	0	0	0	273
Automobile parts	189	74	20	382	142	83	3	1	28	5	2	0	39	909
0 - 4 years	80	31	3	155	58	55	3	1	1	5	2	0	12	394
5 - 9 years	28	21	10	71	12	7	0	0	0	0	0	0	0	148
10 - 19 years	54	22	4	152	70	17	0	0	27	0	0	0	27	346
• 20 years	8	0	3	4	2	4	0	0	0	0	0	0	0	21
Electricity	343	30	55	312	115	91	11	0	1	6	8	1	27	973
0 - 4 years	36	0	5	55	18	17	4	0	0	2	4	0	10	141
5 - 9 years	163	23	22	152	57	51	4	0	0	2	4	0	10	478
10 - 19 years	82	5	17	81	19	19	3	0	1	2	0	1	7	230
• 20 years	62	2	11	24	21	4	0	0	0	0	0	0	0	124
Agric. machinery	100	10	9	118	39	30	14	1	2	2	1	0	20	326
0 - 4 years	1	0	0	3	2	2	5	0	0	2	0	0	7	15
5 - 9 years	14	0	3	18	8	5	9	0	1	0	1	0	11	59
10 - 19 years	33	0	4	28	14	2	0	1	0	0	0	0	1	82
• 20 years	52	10	2	69	15	21	0	0	1	0	0	0	1	170

Sector	Conventional lathes	Conventional boring machines	Conventional shapers	Conventional drilling machines	Conventional milling machines	Conventional grinders	NC lathes	NC boring machines	NC drilling machines	NC machining centres	NC milling machines	NC grinders	NC Total	TOTAL
Machine tools	154	20	42	98	99	106	3	2	0	8	2	9	24	543
0 - 4 years	30	5	7	18	9	9	1	2	0	2	0	7	12	90
5 - 9 years	84	8	21	44	48	80	1	0	0	5	2	2	10	295
10 - 19 years	32	7	13	17	28	15	1	0	0	1	0	0	2	114
+ 20 years	8	0	1	19	14	2	0	0	0	0	0	0	0	44
Heavy machinery	90	23	35	64	17	13	9	5	3	4	5	0	26	268
0 - 4 years	7	1	1	15	4	5	3	2	0	9	1	0	6	39
5 - 9 years	41	10	17	20	4	4	6	3	3	4	4	0	20	116
10 - 19 years	29	9	13	18	6	3	0	0	0	0	0	0	0	78
+ 20 years	13	3	4	11	3	1	0	0	0	0	0	0	0	35
Food industry equipment	204	10	19	121	42	29	2	0	0	1	0	0	3	428
0 - 4 years	39	0	0	56	10	10	1	0	0	1	0	0	2	117
5 - 9 years	93	5	12	35	15	9	1	0	0	0	0	0	1	170
10 - 19 years	60	5	6	27	9	7	0	0	0	0	0	0	0	114
+ 20 years	12	0	1	3	8	3	0	0	0	0	0	0	0	27
Various industrial equipment	91	4	10	62	24	15	1	3	0	0	0	0	3	210
0 - 4 years	6	2	2	1	1	3	1	0	0	0	0	0	0	16
5 - 9 years	37	1	3	24	8	7	0	3	0	0	0	0	3	83
10 - 19 years	30	0	1	34	15	3	0	0	0	0	0	0	0	84
+ 20 years	18	1	3	3	0	2	0	0	0	0	0	0	0	27
Glass industry	21	0	2	3	12	3	18	0	0	18	18	0	54	95
0 - 4 years	0	0	1	0	2	0	17	0	0	18	18	0	53	54
5 - 9 years	11	0	1	3	5	2	1	0	0	0	0	0	1	23
10 - 19 years	10	0	0	0	5	1	0	0	0	0	0	0	0	16
+ 20 years	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	3588	415	449	2791	1153	998	197	21	45	89	45	12	409	9803
0 - 4 years	538	59	46	530	207	190	103	7	4	49	30	8	201	1771
5 - 9 years	1130	121	154	879	332	359	69	11	8	31	15	3	137	3112
10 - 19 years	1181	108	151	907	380	191	25	3	32	9	0	1	70	2988
+ 20 years	739	127	98	475	234	258	0	0	1	0	0	0	1	1932

2. Problems associated with the diffusion of machine tools

2.1 The size and requirements of the market

Even though there was poor protection of the market in the past, we have seen, when examining the capital goods sector, that in many cases there are nevertheless numerous producer enterprises for each production subsector. In that respect it can be considered that there has always been a certain amount of competition among national producers in the segments sheltered from competition.

The market segments aimed at have been the segments of a single internal market with economies of scale which remain small and prevent high investments from being profitable if, in addition, the number of operators is high. Moreover, these internal market segments have often made do with quality criteria below international standards; this has not encouraged suppliers to make the technological effort that would have led them to use more modern equipment and which would have encouraged machine tool producers at the same time to produce equipment of that kind.

Examination of the park of capital goods producers confirms this analysis. The greatest modernization is associated, for instance, with a decrease in the number of operators, including in the case of high demand; this applies to the producers of glass industry equipment who have been able to meet the requirements of local clientele whose demands are linked to their own level of competitivity. Modernization may also be linked to the presence of branch operators of foreign firms, the clientele of which is still independent and demanding; this applies to the producers of oil-field equipment.

The conclusions reached by NAFIN in its survey of 1987 take these variables into account (see the chart on the next page), but without it being possible to completely follow the classification emerging from it. For example, the Mexican machine tool producers have occupied a segment of the market, which is certainly of limited size, but also not really demanding. If they had managed to produce more efficient machines of better quality, they would have been able to challenge the imports and to gain access to a more demanding market where batch manufacture with automated assembly lines was justified by a market of larger size. We can easily see that specialization is then necessary and that the size of the internal market may remain inadequate. However, the local availability of quality machine producers is in turn a requirement for the producers who have to buy this type of product. This means that the present obsolete state of the machine tools manufactured locally is an obstacle to the diffusion of more sophisticated equipment.

Market characteristics and producers of capital goods

DEMANDING	PEMEX	Oil-field equipment	Boats Light aircraft
	Glass industry	Equipment and machinery ←	Machinery ← Tools
	CFE (Electricity Co.)	Electrical equipment	Agricultural machinery Building machinery
	Automotive	Automobile parts	Dies and castings
	Electronics	Components	
NOT VERY DEMANDING	General industry	Compressors Pumps Valves	Auxiliary textile equipment
	HIGH VOLUME - Sufficient demand - Not very much split up		LOW VOLUME - Little demand - Split up

Source: Based on NAFINSA, 1987, p. 29.

2.2 Factors affecting potential diffusion

(a) Machine tool importers

There are about 20 machine tool importers, each one with exclusive contracts with a number of manufacturers. Information communicated by two of them relate therefore to the importers who each sell about 30 machine tools each year, among them about 12 with numerical control. On the one hand, they only serve as middlemen between the foreign manufacturer and the local client and, on the other hand, with the aid of skilled staff - often recycled to the manufacturer - they provide an installation and post-sale service.

The importers thereby represent a diffusion factor for the middle-size domestic clients. Nevertheless, their role is relative. As we have pointed out, they continually need to replace their clientele, who try to make their machines last as long as possible and it often happens that importers are asked for spare parts for machines more than 20 years old. The economic situation is obviously responsible at least to some extent for this behaviour. One of the more dynamic areas of the present market over the last few years (and therefore subsequent to the survey conducted in 1985) is said to be that of the automobile part manufacturers. The manufacture of cars by multinational branches is in full swing with a big export market, but at the same time a certain degree of national integration has to be observed (70 per cent), which is an appeal to numerous local suppliers and subcontractors. The demands of the clients submitting orders are encouraging the latter to acquire equipment. This is a market for importers which they can supply, provided they act as advisers for their clients and make certain there is a high-grade after-sale service available.

(b) International industrial co-operation

During its survey of a thousand enterprises manufacturing capital goods in Mexico, NAFINSA traced, among other things, the existence or non-existence of CAD/CAM systems. As mentioned above, the only place where their use was really confirmed were the manufacturing plants for glass industry equipment. There are only three other occasions on which the report mentions CAD/CAM systems. Firstly, in the case of manufacturers of machinery and equipment for the extractive and building industries (p. 100). The latter seem to produce high-grade products, but with processes that are less automated than those of the larger world market firms. However, three enterprises appear to be on the point of using computers. Then, among the enterprises making electric motors and generators, three enterprises are using computer-aided design (p. 470). This is happening against a background of international co-operation with technology transfers and training of the "designers" by the firms concerned: "the designs are normally not their own: they are developed on the basis of those offered by the foreign enterprises, with which they have technology transfer relations". International industrial co-operation thus appears as a source of diffusion of modern design methods. In this example, that does not go as far as production where the processes are still non-automated, which puts these enterprises - non-dependent on foreign capital - at a productivity level very much below that of the world: the ratio is given as 1 to 6 (p. 471).

Finally, there remains one final, unique case (quoted on page 152) of an enterprise manufacturing heavy machinery that is already far advanced in the use of a computer-aided design system while most of its fellow concerns are only just beginning to use and develop computers for managing their production.

Although we were not able to determine which enterprise NAFINSA had in mind, we obtained information from one of the companies in the same subsector - CLEMEX - which might have been the enterprise meant and which represents a case of some interest. This enterprise is already of considerable size compared with all the others in the capital goods industry as listed by NAFINSA: it employs in fact more than 500 persons, among whom are 45 engineers and roughly 100 skilled technicians.

Its production equipment consists of 62 machine tools, of which 37 are the metal-cutting type and among them there are a dozen numerically-controlled devices. The latter are relatively sizeable machines and one of them is a boring-drilling machine specially built for the enterprise (see the following table on the characteristics of four of the machines used by this firm). The enterprise also has data-processing equipment for programming its machines and designing the products ordered by its clients. Among the latter we find such national exacting clients as PEMEX (oil company) or CFE (Federal Electricity Company), the Mexican iron and steel works as well as branches of multinational companies, just as exacting, such as Brown Boveri Mexicana, Hitachi Zosen or Westing House Corp., to give an example of countries of origin such as Switzerland, Japan and America.

It is of interest to throw light on the origin of this firm, which designs and manufactures blast furnaces, converters, centrifugal compressors and so on. It has been operating since 1982 as a joint venture between a semi-public enterprise of the iron and steel industry (SIDERMEX Foundry), which possesses 60 per cent of the capital, and the French group Creusot Loire (40 per cent of the capital). The equipment installed in 1982 was selected by Creusot Loire - it includes, however, among the conventional machinery some Mexican equipment (made by Oerlikon, FANHAMER and MECOMEX) - which partly transferred its technology by taking on Mexican engineers as trainees (in France). The technological mastery is sufficient today for ensuring maintenance of the equipment and operating a research and development department which designs products and production processes. Nevertheless, for the moment, the existing equipment is a constraint: the products have to be manufactured with it. The enterprise is waiting for a better economic situation in order to move forward. It should be noted, however, that the decision to set it up was adopted in 1979 during a relatively enthusiastic period, and was put into effect right at the beginning of the recession. What was planned as being operational during the growth phase therefore went along very well during the recessive phase. Without wishing to predict the future of this enterprise, it should be noted, first and foremost, that industrial co-operation going as far as a joint venture seems to be a fairly effective way of diffusing the use of modern production methods.

MACHINE SHOP

- Surface covered: 4,628 m^2
- Hoisting capacity: 3 cranes (10-50 t)

MILLING AND BORING SECTION

FM 101 - 1 numerically-controlled milling-boring machine

MAKE: St. Etienne MO
TYPE: FCA
MODEL: 175

Travel: 8,000 x 3,500 x 1,610 mm
Table size: 10,500 x 5,250 mm
Maximum table load: 10 t/m^2
Power: 55 kW
Milling spindle section: 450 x 450 mm
Drilling spindle diameter: 175 mm

Adjustable rotating table: 1,200 x 1,200 mm
Maximum load 10,000 kg

FM 102 - 1 numerically-controlled milling-boring machine

MAKE: LINE
TYPE: MO Dumill
MODEL: M1

Travel: 3,997 x 2,000 x 1,800 mm
Table size: 3,500 x 1,600 mm
Maximum table load: 15,000 kg
Power: 20 kW
Milling spindle section: 350 x 350 mm

TURNING SECTION

TV 101 - 1 numerically-controlled vertical lathe

MAKE: ACME
TYPE: VBM
MODEL: 26/450-200

Table diameter: 3,000 mm
Maximum turning diameter: 4,500 mm
Maximum load: 30,000 kg
Power: 55 kW
Inner and outer grinding device
Outer grinding:
Minimum diameter: 0
Maximum diameter: 4,145 mm
Inner grinding:
Minimum diameter: 400 mm
Maximum diameter: 4,500 mm

TP 101 - 1 numerically-controlled parallel lathe

MAKE: St. Etienne MO
TYPE: Parallel NC
MODEL: HE-1152

Maximum turning diameter over the base: 1,200 mm
Maximum turning diameter over the carriage: 650 mm
Space between points: 4,000 mm
Load between points: 6,000 kg
Power: 45 kW

(c) Direct foreign investment

Justification is sometimes put forward for the idea that the modernization and automation of equipment could be the origin of the preferential and systematic relocalization of production facilities in industrialized countries. We would like here to justify the opposite idea by quoting the example of the manufacture of touring car engines by the larger multinational companies, in particular American firms, in Mexico. For this purpose, we will use a study made by H. Shaiken and S. Hezenberg (1987) which ends with the following conclusion: "As United States industries continue to automate, off-shore production may rise instead of falling" (p. 120).

Their study compares three plants for the production of similar engines, one in the United States, the other in Canada, and the third recently set up in Mexico. What happens in the latter case is not an isolated incident since Mexico has other engine-making facilities (see the table on page 53) and exports about 1.4 million of them at a value of $1.4 thousand million (in 1988). When the Mexican establishment studied was first set up, the multinational firm decided to opt for the installation of the most modern techniques of that time (1980), with the introduction of the most advanced automated technologies. The official responsible for the firm's production processes stated: "The Mexican processes represented our latest state-of-the-art. They are better than we have here [in the USA] because it is our latest plant".

This does not mean a workshop without human beings, but rather sophisticated machines controlled by operators, with lines served by a system of wire-guided cars and relay bays later replaced (from 1984 onwards) by programmable automated devices, which soon proved to be more reliable and easier to maintain. The manpower employed is therefore to a large extent skilled: out of 400 direct jobs, 150 were skilled jobs and the enterprise undertook not to take on skilled workers employed elsewhere. It therefore offered 150 grants for training which was organized by the local technological institute with a suitable programme supplemented for 35 of the trainees by a three-month training period in United States workshops.

The net result is not only that the engines are produced, exported and give satisfaction, but also that the Mexican mastery of a highly modern production process is genuine, for the productivity yields obtained are quite remarkable, 14/ even in comparison with those of the United States and Canadian plants (see table on page 53).

14/ According to the authors, it is still improving and, as they state, "should this trend continue, the plant will be fully competitive with, if not superior to, other engine plants in the United States and throughout the world", (p. 22).

PRINCIPAL MEXICAN EXPORT ENGINE PLANTS, 1987

Company	Site	Projected volume	Per cent export
Chrysler	Saltillo	300 000 a/	85
General Motors	Ramos Arizpe	450 000	95
Ford	Chihuahua	500 000 b/	90
Volkswagen	Puebla	300 000 c/	
Renault	Gómez Palacio	80 000 d/	100
Nissan	Aguascalientes	100 000 e/	

Approximate 1987 engine exports: 1,600,000

Source: Compiled from trade press sources.

a/ This production is above the plant's capacity of 270,000 annually. The plant has exceeded its rated capacity every year since 1984.

b/ This production is above the plant's capacity of 440,000 annually.

c/ This is the projected 1987 export volume for the plant. An expansion is currently under way to boost capacity to 500,000 annually.

d/ This volume is well under the plant's capacity.

e/ This is entirely an export figure.

THE MEXICAN HOURLY WORK-FORCE

Category	Average age	Education				First job
		Secondary	Technical	Preparatory	University	
All hourly	22	113	61	177	28	231
(in per cent)		(30)	(16)	(47)	(7)	(61)
Skilled workers	23	2	39	55	11	
		(2)	(36)	(51)	(10)	
Production workers	22	111	22	122	17	
		(4)	(8)	(45)	(6)	

Source: H. Shaiken and S. Herzenberg.

1985 MACHINE YIELD

(United States engine 1985 average on each line = 100)

Machining line	M (As of 30/S or 31/10)	A (As of 1/7 except as noted)	C, V-6 (As of 31/8 except as noted)
Crankshaft	71 (10) b/	100 a/ (5)	81 (0)
Cylinder block	94 (29)	100 (0)	105 (0)
Camshaft	61 (-6)	100 a/ (1)	79 (-3)
Cylinder head	115 (26)	100 (3)	107 (-4)
Intake manifold c/	80 (35)	100 d/ (27)	94 NA
Piston	63 (45)	100 (4)	104 NA
Unweighted average	80 (21)	100 (6)	95 NA
Average weighted by capital cost	81 (18)	00 (4)	92 NA

Source: Compiled from company figures.

a/ The North American version of this part is machined at a plant other than the one that makes the rest of the engine.

b/ Numbers in parentheses indicate the percentage improvement over performance in 1984, to the nearest whole percentage point.

c/ The remaining machining lines are not ordered by value added.

d/ Year-to-date average as of 1 November 1985.

More generally, it encourages foreign investors not to practice, as they have sometimes been tempted to, downscaling in order, as they believe, to adapt the technologies to existing skills; it is possible, in Mexico in particular, to teach the work-force skills and to attain, with modern equipment, genuine world-standard productivity. Within the context of interest to us, this is, of course, a factor for added potential diffusion of modern equipment, since Mexico remains, for different reasons, a major welcomer of foreign investments, especially from the United States.

CONCLUSIONS

The descriptions and analyses given in this report enable us to make certain statements and to draw certain conclusions.

(1) The production of machine tools in Mexico is really very low and relates solely to traditional machines.

(2) It does not seem likely that the manufacturers in operation will either in the near future take a major share of the 10 per cent of the market they have missed, or that they will turn out more complex machines.

(3) Diffusion of the modern equipment is still very limited, especially within the capital goods industry as a whole, except for a few special cases and the automobile industry.

(4) The difficult economic situation of the 1980s does not seem in the least responsible for this state of affairs, even if it has clearly not led to a different trend.

(5) The Mexican human and technological resources are no longer in doubt, as shown by numerous examples, 15/ and the potential for the diffusion of modern equipment is considerable.

(6) On the assumption of the resumption of lasting growth in the 1990s, we should therefore expect modernization of the equipment, which could be done by broadening the market supplied, first and foremost by imports.

(7) Those responsible for the industrial policy certainly hope that, conversely, local production of machine tools will be developed. The capital goods sector will be considered as a priority sector by the future PRONAMICE (National programme for industrial modernization and foreign trade), a 1990-1994 government programme due to be published shortly.

(8) The choice of ways and means is clearly very limited. If it is wished to proceed efficiently and fairly rapidly, an international industrial co-operation project will have to be developed, with direct investment, either as a joint venture or not, in order to manufacture a category of particular importance to the Mexican market and not just make a whole range of machine tools.

(9) Implementation of a programme of this type is not clear-cut, since the choice of a foreign partner and his participation are linked, in particular, to the operating conditions of the world machine tool industry and to the chances for international co-operation with the Mexican State. We should note, among other things, that we have encountered no trace of positive effects sensitive to Latin American co-operation, either in the Mexican machine tool industry or even in the capital goods industry.

15/ We could also have cited, for example, the Cinvestar project for creating an intelligent robot (Jornada, 24 July 1989).

REFERENCES

H. SHAIKEN
S. HERZENBERG
Automation and global production automobile engine prodution in Mexico, the United States and Canada
Center for U.S.-Mexican studies, University of California, San Diego, 1987, 120 pages.

WORLD BANK
Mexico. Manufacturing sector: situation, prospects and policies
The World Bank, Washington, 1979, 174 pages.

ONUDI
Situation y perspectivas de las industrias de bienes de capital en America Latina. Volumen I **: Mexico**
PPD-14, 11 dic. 1986, 55 pages.

NAFINSA-ONUDI
Mexico: los bienes de capital en la situación economica presente
NAFINSA, Mexico, 1985, 374 pages.

J. MALKUS
Study on strategy for promotion of machine tool industry in developing countries. Mexico
UNIDO/ID/WG.314/3, 26 Nov. 1979, 84 pages.

NAFIN
Estudio de la capacidad instalada, potencial technológico y ventajas comparativas de la industria de bienes de capital
Nacional Financiera SNC, Mexico, dic. 1987, 574 pages.

ECE
Engineering indsutries. Dynamics of the eighties
United Nations, New-York, 1988, 289 pages.

UNIDO
Technological perspectives in the machine tool industry and their implications for developing countries
United Nations, New-York, (ID/312) 1985, 90 pages.

UNIDO
Recents developments in the machine tool industry : the prospects for foreign direct investment with particular reference to asian developing countries
UNIDO/PPD-53, 16 Sept 1987, 58 pages.

UNIDO
Technological requirements for the machine tool industry in developing countries
UNIDO/IS.642, 24 June1986, 71 pages.

NAFINSA — **Una estrategia para desarrollar la industria de bienes de capital**
NAFINSA, Mexico, 1977.

UNIDO — **The capital goods industry in Latin America: present situation and prospects**
UNIDO/IS.478, 17 July 1984, 110 pages.