le Federal do Rio de Janeiro

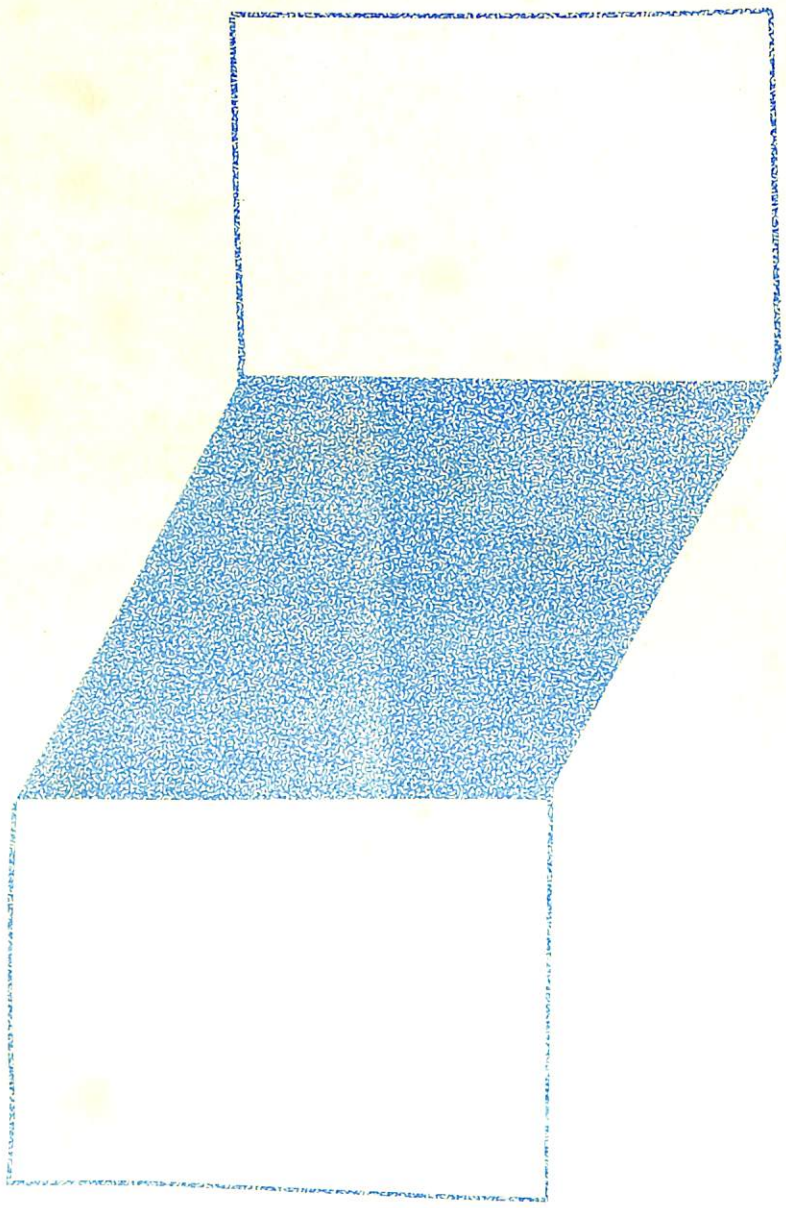
Instituto de Economia Industrial

TEXTO PARA DISCUSSÃO Nº 64

EMPLOYMENT EFFECT OF MICRO-ELECTRONIC EQUIPMENT IN THE BRAZILIAN AUTOMOBILE INDUSTRY

José Ricardo Tauile

Dezembro de 1984



UNIVERSIDADE FEDERAL DO RIO DE JANEIRO
INSTITUTO DE ECONOMIA INDUSTRIAL

Employment effect of Micro-Electronic equipment in the Brazilian automobile industry *

José Ricardo Tauile

* Este texto está sendo fotocopiado numa edição limitada como Texto para Discussão por especial deferência da Organização Internacional do Trabalho.

anpec Associação nacional de centros de pós-graduação em economia

Este trabalho foi impresso com a colaboração da ANPEC e o apoio financeiro do PNPE

PROGRAMA NACIONAL DE PESQUISA ECONÔMICA PNPE

FICHA CATALOGRÁFICA

Tauile, José Ricardo
Employment effect of micro-electronic equipment in the Brazilian automobile industry/José Ricardo Tauile.-- Rio de Janeiro:UFRJ/Instituto de Economia Industrial, 1984.
32 p.--(Texto para discussão, n.64)

WORLD EMPLOYMENT PROGRAMME RESEARCH

Working Paper

Technology and Employment Programme

EMPLOYMENT EFFECT OF MICRO-ELECTRONIC EQUIPMENT IN THE BRAZILIAN AUTOMOBILE INDUSTRY

by

José Ricardo Tauile

Note: Working papers are preliminary material circulated to stimulate discussion and critical comemnts.

ISBN: 92-2-103925-0

August 1984

FOREWORD

This working paper by Mr. José Ricardo Tauile of Instituto de Economia Industrial, Universidade Federal do Rio de Janeiro, is the second in a series on the employment effect of micro-electronics in the automobile and auto-parts manufacturing industry.

Based on a review of literature on the Brazilian automobile industry and field work, this report assesses the extent of diffusion of micro-electronic technology and evaluates its impact upon industrial organisation and upon employment in this industry. Although the diffusion of micro-electronic equipment is still in its initial stage not only in the automobile industry but also in the Brazilian industries in general, the Brazilian automobile industry appears to be entering a new phase of development, which is characterised by the introduction of ME equipment. Application of such new technology seems to be associated with the release of the "world cars" and tends to raise the technological standard of the local industry to the international level. This is closely related to the export of automobiles, which is gaining importance as the home market shrinks due to the economic crisis in Brazil. The low labour costs, however, tend to discourage the diffusion of micro-electronic equipment.

Partly because of the limited application of the new technology, its negative employment, if any, appears marginal in the face of the enormous structural and cyclical unemployment that the economic crisis of the country has given rise to since 1980. Nonetheless, workers have begun to voice their concern about potential negative employment effect of micro-electronics. The Government appears to be in a dilemma between the need for early diffusion of such technology for the purpose of increasing the international competitiveness of local industry and maintaining or accelerating the industrial growth on the one hand, and, on the other, the need for import restriction regarding the micro-electronic equipment for the purpose of fostering indigenous capacity to develop and produce such equipment.

ACKNOWLEDGEMENTS

I am indebted to many entrepreneurs, managers, technicians, workers, and colleagues for their patience and willingness in helping me in this research project. I owe special thanks to Renato T. Izar for his assistance in reviewing historical material, making contacts for visits and interviews, and collecting and organising statistical information; to SOBRACON for sending out the questionnaires; to Janet T. Yousset for her secretarial work; to Fabio Erber and Susumu Watanabe for their careful reading and comments on the earlier drafts; to Vera Ribeiro for reviewing the English composition and grammar of the text of the first draft and typing it in due time; and to Marilia dos Santos Amorim for more than I could describe here, always with much love and stimulus. Of course, the responsibility for the content of the text is entirely my own.

José Ricardo Tauile

TABLE OF CONTENTS

FOREWORD

ACKNOWLEDGEMENTS

I. General Background of the Brazilian Automobile Industry..... 2

II. AssemblerS and New Technologies..... 8

III. Auto-parts Manufacturers and ME..... 17

1. The structure of the auto-parts manufacturing sector..... 17

2. Diffusion of ME equipment..... 19

IV. Impact on Employment and Labour..... 24

1. Employment impact..... 24

2. Effects on work organisation..... 27

V. Summary and Conclusions..... 28

Notes

References

List of Working Papers

EMPLOYMENT EFFECT OF MICRO-ELECTRONIC EQUIPMENT IN THE BRAZILIAN AUTOMOBILE INDUSTRY

The main objective of this study is to assess impacts of micro-electronic (ME) "new technologies" - numerically controlled machine tools (NCMTs), robots, and programmable controllers - on employment, work and industrial organisation in the Brazilian automobile industry, including both the final assembly of cars and trucks and the auto-parts manufacturing.

Section 1 contains a brief historical review of the development of this industry, providing basic ground for our analysis. It will be argued that the use of micro-electronic equipment in this industry is just beginning, and that there is some indication of an increasing degree of integration of the industry in a global process of competition and accumulation. Likewise, there arise new possibilities of involvement of the local labour force into the international division of labour. Section 2 is concerned with the extent and pattern of diffusion of micro-electronic equipment in the assembly sector of the industry, and its relationship with the industrial organisation. It will be pointed out that local economic conditions and multinatonal automobile companies' strategies have been influencing the diffusion of new technologies in this industry. Section 3 deals with the auto-parts manufacturing sector where the new technology spreads, partly, as a response to assemblers' policies. Section 4 will examine the impact of micro-electronic equipment on employment, work organisation and industrial relations.

Our analysis in Sections 2, 3 and 4 is based on (a) information obtained from official institutions; (b) visits to four major car assemblers (GM, Ford, Volkswagen and Fiat), three truck producers, and one jeep producer who accounted for over 98 per cent of total automobile production in Brazil in 1984; (c) visits to 13 auto-parts producers including eight users of NCMTs; and (d) replies to questionnaires sent to the auto-parts producers WHO we had identified as NCMT users. Fifty questionnaire forms were sent out, but only 14 were returned including 7 of the 13 firms in (c). We also interviewed members of the boards of directors of manufacturers' associations like ANFAVEA (National Association of Motor Vehicles Manufacturers), SINDIPEÇAS (National Association of Auto-parts Manufacturers) and ABIMAQ (Brazilian Association of Machine Industries), as well as representatives of related government agencies like SEI (Special Secretariat of Informatics) and MIC (Ministry of Industry and Trade). Contacts were also made with workers through DIEESE (Departmento Intersindical de Estatística e Estudos Sócio-Econômicos (Inter-union Bureau of Statisics and Socio-Economic Studies).

Our study was considerably constrained by the paucity of statistical data. There is no adequate data published by the Government or workers' unions, nor can it be made available by firms in a systematic form. At the time of writing, the Brazilian economy is in a serious crisis, one of its most severe social effects being high levels of unemployment and underemployment. The relationship between automation and unemployment is an extremely delicate issue, and firms are wary of discussing it. The major metalworkers' union in the industry (in Sao Bernardo do Campo, Sao Paulo) has been under federal intervention since the first half of 1983, which makes it even more difficult to gain access to and gather relevant data.

In addition, the fact that the diffusion of ME equipment is still in its initial stage makes it virtually impossible to carry out a systematic and exhaustive assessment of current trends, given the material constraints of our project. Some steps have nevertheless been taken by the Special Secretariat for Informatics (SEI), which is linked to the National Security Council, to abridge somewhat the enormous gap of information about industrial automation in Brazil. A Special Commission on Manufacturing Automation (CEAM) was formed during the first half of 1983 to evaluate the manufacturing automation process and assist SEI in policy making. It was composed of representatives of the society at large who were concerned with the matter. Three different subcommittees were put in charge of technological issues, industrial and market aspects, and socio-economic impacts. The final reports on the work of the subcommittees were presented at the First National Congree on Industrial Automation (CONAI), held in Sao Paulo in July 1983. Some of the information contained in those reports, which may be regarded as the most up-to-date published data from official sources so far, was useful for our study.

I. General Background of the Brazilian Automobile Industry

Before 1950, automobile producers in Brazil restricted themselves to assembling imported CKD vehicles. The auto-parts sector, in turn, seldom showed any sign of vitality, except when the supply of imported parts was cut off, e.g. during the Second World War. Its market was confined to replacement parts, and production techniques were rather rudimentary and improvised.

From the beginning of that decade onwards, however, a series of policy measures were taken by the Brazilian Government showing a clear intention of establishing industrial facilities to manufacture automotive vehicles locally. In 1952, the Federal Government created, through its Industrial Development Commission (CDI), the "Subcommittee on Jeeps, Tractors, Trucks and Cars". One of the latter's very first acts, in August 1952, was a notice

(Aviso de CEXIM no. 288) forbidding the import of any auto-parts produced in the country. In 1953, a new "Aviso de CEXIM" prohibited the import of fully assembled motor vehicles. Other measures were added to these acts, such as tariff exemption for the import of machine tools, which induced entrepreneurs to invest in the auto-parts sector. A survey conducted by the National Syndicate of the Industry of Automotive Vehicles Components discovered that out of the 678 firms surveyed in the sector, 159 had established themselves between 1951 and 1955 [(17), p. 28].

During the same period, i.e. in the first half of the 1950s, Willys-Overland came to Brazil to produce jeeps. So did Volkswagen, who wanted to produce cars and vans. But it was only in the second half of the decade, after the creation of the Executive Group of the Automobile Industry (GEIA) in 1956, that the industry really began to develop. In that year, GEIA approved 17 projects, out of which 12 were implemented.

American firms' entry into the Brazilian market was rather slow at the beginning. GM and Ford produced only trucks, while Chrysler entered indirectly through their minority shareholding in the French Simca (Willys-Overland also had a minor participation in Willys do Brasil). It was European firms such as Volkswagen and Daimler-Benz that took the lead in the production of cars and trucks, respectively. Auto Union was only a Vemag licenser.

After 1955, the Government permitted import of used machines to promote industrialisation - "Instruçao 113" by SUMOC (Money and Credit Superintendency). This was very important for the establishment of the Brazilian automobile industry, which began to produce obsolete models that were often out of production elsewhere, using outdated production methods. Governmental support to promote the automobile industry was not restricted to provision of such direct incentives. During the Kubistchek years (1955-1961), for example, there was a marked expansion of road construction and paving. The Brazilian highway network extended by 40,000 km in that period.

According to Guimaraes [(8)], 1955 was the dawn of the first complete growth cycle of the Brazilian automobile industry, which can be divided into two phases: a phase of very accelerated growth up to 1962, and that of slower growth between that year and 1967.

From 1957 to 1962, production increased more than six times, from 30,541 to 191,1949 units [(18)], to satisfy the demand that had been suppressed since the start of the import restriction at the beginning of the 1950s. This period is also characterised by the appearance of a large number of auto-parts manufacturers. A significant portion of the firms were

foreign-owned. "In some cases the decision of foreign-owned auto-parts producers to invest was spontaneous, stimulated by an expanding market for their products. In other instances, however, the investment was a result of direct pressures exerted by assembler firms which, compelled to meet certain indices of nationalisation, attempted to guarantee the supply of parts and components" [(8), p. 121]. By 30 June, 1962, the rate of local content had reached 86.4 to 94.3 per cent, depending on the type of vehicle produced. Consequently, the auto-parts sector grew at a considerable speed. After 1963, the industry continued to grow, but at a slower pace. The production of vehicles in Brazil fell to 183,707 units in 1964, and went up again until reaching 224,609 units in 1966.

During this first growth cycle, production was not very diversified. By 1967, 51 different models had been introduced, out of which 21 in 1966 and 1967. In the next ten years, 139 new models came into the market. (The concept of model here refer to the whole array of list options deriving from a smaller number of basic cars [(8), pp. 158-159]).

In 1968, the second phase of accelerated growth started. This continued until 1973, and slowed down again after 1974. Product diversification increased to meet the demand in the upper income market. The market for used cars also showed some growth. Ford and GM started to manufacture cars, and Chrysler began to invest in car production. Some assemblers could not keep up with the new competition and were absorbed: Willys by Ford, Vemag by Volkswagen, Simca by Chrysler, and Fábrica Nacional de Motores (FNM) by Alfa Romeo. This wave of takeovers eliminated the two major national producers - Vemag and FNM.

Production technology was still not up to the international standard, as part of the investment during this period was still devoted to the transfer of used machinery from factories abroad. Between 1966 and 1974, however, the annual output of vehicles per worker doubled (see Table 1). This increase in productivity may be explained "... by several factors - improved machinery, change in the relation between the number of production workers and indirect labour employed, etc. - but there seemed to be a lot of pressure on the workers to intensify their effort at work. By the time of the interviews ... a reduction of production was accompanied by a drive to increase profits. There were lots of pressures to increase production per worker without changing the techniques of production" [(9), p. 89]. The real wage in the industry was at the same level in 1974 as in 1966, after having increased by 17 per cent in 1972 [(11), p. 81].

After 1974, despite the slowdown of the growth rate of the industry and the opposition of already existing firms, Fiat and Volvo started their production in Brazil. Fiat received strong governmental support through a significant participation of the state of Minas Gerais in the investment, as its car factory was located in that state. Fiat also entered the truck market by acquiring Alfa Romeo and using its production facilities in the state of Rio de Janeiro. Volvo was specialised in the production of trucks and buses. Both companies used advanced technologies of that period, such as tranfer machines designed for the production of one basic model. The last big takeover in the Brazilian automobile industry occurred in 1980, when Chrysler was absorbed by Volkswagen.

Until 1980, the automobile production kept growing fairly steadily with only one exception of 1977, although more slowly towards the end of the period (Table 1). However, the crisis of the Brazilian economy, which was triggered off, among other factors, by the second oil crisis in late 1979-80, hit the industry very hard. The extremely high interest rate on consumers' loans discouraged the purchase of cars: "... the cheaper loan to buy a (brand new) car (in 24 months) costs (currently) 150% per annum, or - something to feature in a book of records - the equivalent of more than five cars at every two years of instalments" [(14)]. The Government's restriction on oil consumption had a similar effect. The production level in 1983, although higher than those of 1981 and 1982, was still lower than the level reached between 1974 and 1980. This has brought about very serious employment problems (Table 2). In the production of buses and trucks, there is still no sign of recovery at the time of writing.

Export of automobiles has been stimulated by the creation, in 1972, of BEFIEX (Banco do Brasil's Commission for the Concession of Fiscal Benefits and Special Export Programmes), which aimed at promoting the growth of Brazilian exports and reducing the foreign subsidiaries' excessive dependency on their principal companies regarding the export policy. "These BEFIEX programmes allowed the firms who committed themselves to making a certain volume of exports to benefit from a series of concessions, such as exemption from import duties and from taxation on imports of industrialised products linked to export activities. These imports were not subject to the similarity clause - concerning capital goods and raw materials - but were limited by a specific percentage of the value of exports" [(7)]. Forty per cent (in terms of value) of all export deals handled by BEFIEX up to 1981 were related to the automobile industry [(1)]. As shown in Table 1, exports rose to nearly 35 per cent of the automobile production in 1981. In 1971 assemblers in Brazil

Table 1

Production, Employment, and Exports in the Brazilian Automobile Assembly Industry

Year	Production (thousand units) (1)*	(2)**	Total	Annual average number of employees	Vehicles produced per worker	Exports (thousand units) Units	Annual growth (%)	Export/ production (%)
1966			225	51,410	4.4 (100)***			
1967			225	49,135	4.6 (105)			
1968			280	55,193	5.1 (116)			
1969			354	63,513	5.6 (128)			
1970			416	64,075	6.5 (149)			
1971			516	70,272	7.3 (169)			
1972	522	100	622	75,417	8.2 (189)	13		2.5
1973	620	130	750	88,625	8.5 (198)	24	81.1	3.9
1974	754	151	905	104,155	8.7 (199)	64	163.9	8.5
1975	779	151	930	104,455	8.9 (204)	72	12.8	9.2
1976	834	152	986	106,568	9.3 (212)	80	10.2	9.6
1977	775	146	921	111,562	8.3 (189)	70	-12.9	9.0
1978	925	139	1,064	116,225	9.2 (210)	96	37.3	10.4
1979	967	160	1,127	124,567	9.0 (207)	105	9.9	10.9
1980	982	183	1,165	130,414	8.9 (204)	157	48.7	16.0
1981	625	156	781	115,871	6.7 (154)	212	35.4	33.9
1982	720	141	859	106,311	8.1 (185)	173	-18.4	24.0
1983	774	122	896	103,517	8.7 (198)	169	- 2.3	21.8

* Cars, vans, and utility vehicles
** Small trucks, trucks, and buses
*** The figures in parenthesis indicate indices (1966=100).

Source: ANFAVEA.

Notes:

1. Major car assemblers are Volkswagen, GM, Ford, and Fiat.
2. Major truck assemblers are, in addition to the foregoing, Mercedes Benz, Saab Scania, and Volvo.
3. In the period considered there was no CKD assembly in Brazil.

exported to 16 countries (two of them accounted for 63 per cent of total exports), and in 1980 to 77 countries (three of them accounted for 51 per cent of total exports) [(2)].

However, Brazil's automobile export has been facing increasing obstacles, the major ones being the economic crisis of importing countries and the strong competition posed by Japanese cars, which account for two-thirds of the imports by Third World countries (even in Latin American countries such as Argentina, Uruguay and Chile, the Japanese share in car imports has been growing). Some Brazilian assemblers have been trying to cope with this by exporting CKD vehicles, in order not to lose economies of larger-scale production.

Table 2

Employment in the Brazilian Automobile Industry: 1974-1983

(In thousands, as of 31 December of each year)

Year	Auto-parts (A)	Final Assembly (B)	Total
1974	200	104	304
1975	230	105	335
1976	226	112	338
1977	235	113	348
1978	270	119	389
1979	273	128	401
1980	279	133	412
1981	198	104	302
1982	219	107	326
1983	215	101	316

* The figures in column B differ somewhat from the corresponding figures in Table 1, for there it refers to the annual average.

Concerning other recent international trends, two assemblers installed in Brazil have released so-called "world cars" (a concept which may not be very precise or too new; one assembler's representative said that they had been producing world cars since the 1930s). GM introduced Monza (Ascona) in 1982, and Ford Escort in 1983. Volkswagen is expected to follow suit with

Santana and Fiat with Uno, both in 1984. A greater degree of exchange of parts and components may be expected among several production branches of the same corporations scattered throughout the world, but exactly how far this will go would seem to depend largely on the flexibility of policies of their host countries regarding import of parts and components.

Such global strategy of multinationals has some adverse effects on the Brazilian automobile industry, since certain parts of the vehicles are now systematically imported. This naturally constrains the development of the local manufacturing capacity in the related lines of production. As a matter of fact, the export-oriented government policy in the last ten years has allowed assemblers to reduce the local content of their cars to about 85 per cent. The programmes of "world cars" are supposed to reduce the local content even further, down to 75 per cent and this has been, of course, a great threat to the auto-parts sector [(5)] as will be discussed in the next section.

On the whole, however, all assemblers enjoy substantially positive balances of trade; the value of their imports has been far lower than the value of their exports of parts and vehicles. This suggests that by and large the export-oriented policy tends to work in favour of the Brazilian economy and that there is some ground to support the introduction of new technologies including imported equipment, even though the overall policy remains to restrict imports with a view to reducing the foreign debt and protecting the local production of similar equipment.

II. Assemblers and New Technologies

For the Brazilian automobile industry, the early 1980s seems to be a transition period in which competition has been intensified. A set of forces is about to cause significant changes in the industry's organisation and production methods. Such forces may be considered to originate broadly from three different but highly interrelated levels:

a) The shrinking of the internal market after 1980 (Table 1 above) and the extremely serious crisis that has since been affecting Brazilian economy as a whole (in particular, the growing foreign debt).

b) The intensification of competition in the world market for automobiles and the consequent restructuring of the industry at the international level, which was encouraged by the use of new ME technologies [(10)].

c) The availability of locally-produced ME equipment, which entrepreneurs often mentioned as a strong incentive for modernisation.

Let us examine these points in some details and describe how their interaction has resulted in changes in production processes and industrial

organisation. Before we proceed, however, it must be noted that firms do not supply precise information about strategical automation plans even to the Government. At the time of CEAM's study, assemblers refused to disclose their plans on the ground that they were company secrets. Through our visits to the major assemblers, however, we have managed to get a general overview of what they are currently doing or planning to do in the near future to introduce new technologies, as will be discussed below.

The sharp decline in vehcile sales in 1981 left much of the existing (rather inflexible) capacity unused. In 1981, about 110,000 workers were laid off by the industry as a whole and about 30,000 by the assemblers (cf. Table 2 above). Since then competition has become fiercer, forcing the assemblers to reduce costs by means of more efficient organisation and more flexible prodution techniques, and to enhance the appeal to consumers by releasing higher quality basic car models.

To a certain extent, the introduction of new technologies has been intended to increase production flexibility, and thus reduce inventories. The latter also required more efficient handling of materials and organisation of the production system. Virtually all assemblers now adopt some form of "just-in-time" system (naming it "Kamban", "minimum inventory system - SIM", or otherwise) in order to increase productivity, although it is still confined within individual companies and there is not a single case of such a system involving subcontractors. Quality Control (QC) circles have also been widely implemented.[1] The extent and form of organisational change vary according to the degree of cooperation that the employer can secure from his employees, and are limited by the latter's mentality and abilities and by the technical standards adopted [(16) pp. 104-111].

Substitution of new automation technologies for old equipment in the Brazilian automobile industry is still in its initial phase and has limits of its own. Although it tends to directly or indirectly increase productivity, it also implies heavy depreciation allowances and large capital investment which deter it. The cost of displacement of under-depreciated equipment is another problem. A plant manager in a large truck factory told us, "I wish I could substitute 20 NCMTs for 100 general-purpose machine tools in my tool room, but what am I to do with the replaced equipment? No one wants to buy it, even if I offered it at bargain prices."

The drive to attract consumers in the domestic market has stimulated the release of new and more sophisticated higher quality cars.[2] As indicated earlier, two of the four major car assemblers have already manufactured a "world car" and the other two will do the same in 1984. An

important consequence of this move is that it has created an appropriate opportunity for heavy investments in production facilities, thus allowing the application of new technologies into production process and the implementation of new managerial procedures. The implications for the diffusion of ME equipment are straightforward. Similarly designed cars must be manufactured with similar quality standards and techniques, even if produced in different countries. This is even more so when parts and components come from different places.

The engine of the first world car released in Brazil is manufactured in a flexible transfer line, which is controlled by approximately 130 programmable controllers (IPC-ISSC). The time required for reprogramming and setting up the system anew is thereby drastically cut. At the time of writing, this type of flexible transfer line produces six different engine models. The system's capacity is about 2,000 engines per day, and 90 per cent of the output is exported. At the same plant site, the firm in question has modernised the aluminium foundry by installing two casting robots.

The producer of the second world car uses eight welding robots, which are now comonly used in Brazil, the first robot painting chamber and two electronically controlled and flexible multispot welders which perform their functions extremely rapidly. Its welding robots and robot painting chamber were the first of the kinds in the country. This company has also taken the opportunity to modernise its plant by massively introducing programmable controllers in lining up wheels, testing and selecting parts, allocating materials throughout the assembly line, etc.

As a matter of fact, the aforementioned type of flexible multispot welders had formerly been introduced by another assembler early in the decade, when the company released a new model (which was not called a "world car" as yet). They are fed by electronically controlled magnetic trolleys. In 1984, the world car manufactured by this company will be in the market and five welding robots will be used initially in its production.

The fourth assembler has no plan of introducing ME equipment, except the testing equipment which the firm has been using for the production of diesel engines for export.

We have noted that assemblers are increasingly seeking opportunities to use ME devices - such as programmable controllers - to automate even their old production lines. This is the case, for instance, of the final testing of engines and assembled cars, or of the allocation systems which coordinate the supply of parts and components for the different models or variations around the same model along the assembly line. Yet, old technologies are sometimes

adequately used to meet the latest needs, as is the case with a firm which provides this coordination through the use of a conventional but very efficient telex network within the plant.

It is clear that the pace of production technology innovation in the industry will be dictated by that of the introduction of new basic models. All the forthcoming models are associated with major automation plans. Only one firm had no major automation plan, but conceded that some automated equipment would be introduced such as air lift conveyors ("translift") and systems to hold the body of the car together during for welding ("mascherom"), both controlled by ME devices. Presently this firm uses only two NCMTs in car production (and two others in truck production), as low volume production machines. All the assemblers believed that application of advanced technology was required right away so that the workforce could start getting used to the new technologies and receiving adequate training, and that they would not lag far behind the prevailing international patterns of production. The main objective is to pursue efficiency with flexibility and good quality control.

All four major car producers also assemble trucks. They seem to be following a general strategy similar to what we have already discussed with respect to car assembly, except that this is a far less dynamic market and that production lines often employ more conventional methods.

There are three other truck and bus producers (who do not assemble cars) in Brazil. They are all subsidiaries of European corporations. The concept of a world vehicle seems to prevail at two of them. The third one has been established in Brazil for about 25 years and its basic models have changed little over the period. They all have the problem of underutilisation of capacity, but the extent of application of ME equipment varies (Table 3). One firm has been using new technologies - mostly NCMTs - since 1975, and another firm has just begun to use NCMTs though not for the sake of flexibility, but as low volume machines. The last producer, recently established in a rather modern plant, uses no ME equipment. Among all three producers we have found the same tendencies toward reducing inventories, adopting more efficient organisation methods, producing a surplus in their trade balance, etc. As in car production, they introduce ME equipment to replace conentional machines when their serviceable lives come to an end.

Surprising though it may seem, the only Japanese subsidiary in the automobile industry in Brazil is precisely the one that uses the most traditional production methods. It manufactures less than 500 diesel jeeps per month at full capacity (but is currently producing just over 50 per cent of that figure). Not a single ME device is used to automate the plant.

Table 3

The Use of Robots and NCMTs in the Assembly Sector

Firm	Robots		NCMTs	
	Use	Number	Kind	Number
Car assembler A	spot welding*	5	lathes	3
			milling	3
			measuring	1
			other	1
Car assembler B	casting	2	milling	2
			measuring	4
			machining centres	3
Car assembler C	spot welding	8	lathes	2
	positioner for X-ray quality control	1		
	painting	1		
Car assembler D	--	--	lathes	2
			lathes**	2
Truck producer E	--	--	lathes	6
			machining centres	2
			measuring	2
Truck producer F	--	--	lathes	5
			machining centres	1
			other (punching)	1
Truck producer G	--	--	--	
Jeep producer	--	--	--	
TOTAL	--	17	--	40

Notes: * Entering regular production in 1984.
** Used in a truck plant.

However, there is a very efficient internal "Kamban system" and they say there is still much to be done for improving production organisation using the existing traditional equipment (each worker produces one vehicle per month, as compared with five vehicles in Japan). There is no plan of plant modernisation. As regards its integration into the world market, one of the company's staff members stated that "in order to gain the necessary competitiveness, all efforts have been directed to increasing the productivity of our parent company in Japan". The Brazilian plant therefore seems not to be intended for export.

Among ME equipment, NCMTs are the ones for which local production capacity has been most highly developed. This capacity has been developing since the mid-1970s. By 1980, six firms were producing the equipment regularly. Two of them were owned by national private capital, and four by German capital. At the Mechanics Fair held in Sao Paulo in 1982, 16 firms displayed different types of NC equipment (again, the majority of those companies were owned by Germans). The skills for producing the electro-mechanical part of the equipment could be found locally, thanks to the existence of a traditional and well-developed machine tool industry in Brazil. Such skills have also been brought by newly arriving German firms. The capacity for designing and producing NC units has been the object of specific technology transfer policy formulated by the Special Secretariat for Informatics (SEI). At the moment, there are four companies owned by private national capital engaged in the production of NC units in Brazil. They have bought NC designs from foreign firms and have spent four years to absorb their respective technologies. Since the volume of production is modest, however, the NCMTs produced in Brazil cost two to three times the price of their counterparts in the world market. Consequently the number of NCMTs installed in the industry is still modest. The car assembleres are using at least 21 NCMTs (Table 3), but these are used mostly in tool rooms. They have been introduced where versatility and flexibility are required in the machining of small batches of complex-shaped parts (mostly in tool rooms) independently of the release of new models. The flexible manufacturing system (FMS) has not been introduced in Brazil yet.

None of the assemblers have introduced CAD yet, but most of them intend to introduce it in the near future mainly for two purposes: a) to increase the designing capability and thus independence from principal firms; b) to get integrated into the latter firms' global system of production by increasing interchangeability of design and production plans.

Table 4
Mode and Purposes of ME Technology Application at Assembly Plants

Processes and or activities \ Reasons to automate using ME	.Reducing production of scrapped parts	.Absorbing technology (learning)	.Increasing the pace of production (productivity)	.Independence from certain labour skills (skill saving)	.Labour savings	.Better working environment including safety	.Increased coltrol of production flows	.Better quality and higher control over it	.Greater flexibility in production
Machining	5 1	5 2	4 4	2.3 3	1 3	3 5	2.6 3	4.2 5	4.3 4
Machine feeding		3 1	3.3 3	1 2	2 2	4 3	1.5 2	1 2	2 2
Manipulation and transport of materials		2 1	4.5 2	1 2	2.5 2	4.3 3	5 2	2 2	4.5 2
Foundry/forging		4 1	3 3	2.5 2	2 2	4.3 3	4 2	4.5 2	4.5 2
Stamping		5 1	4.5 2	1 2	2 2	3.7 3	3.5 2	3.5 2	4.5 2
Controlling the flows of energy, parts, models, etc.	5 1	5 1	4 3	3.3 3	2 3	2.7 3	3.3 3	4.7 3	3.7 3
Quality control	5 1	5 2	2.7 3	4 3	1.8 4	2.7 3	1.3 3	4.8 5	3 4
Spot-welding		5 1	5 2	3.5 2	3.5 2	4.7 3	4.5 2	5 2	5 2
ARC welding		4 1	4 2	4 2	2 2	5 3	3.5 2	5 2	4.5 2
Assembly		2 1	3.7 3	2.5 2	2.5 2	2.7 3	3.5 2	4 2	4.3 3
Painting	1 1		1 1	1 1	1 1	5 1	1 1	4 1	1 1
Production management		5 1	5 1	4 1	3 1	1 1	5 1	2 1	4 1

Note 1: The matrix indicates the order of importance (5 being the highest) of the reasons which led companies to introduce ME equipment (robots, NCMTs, Pca, etc.)

Note 2: On the upper left part of the square we have registered the simple average of the answers; on the lower right we indicated the number of responses registered in each square.

Note 3: The last two rows and the first two columns were originally headed "Others - please specify", and they were filled out with the answers of only one assembler.

The forms of new technologies with which we are now dealing - NCMTs, robots and PCs - may be used in different processes for different purposes. Table 4 shows the mode and purposes of the application of ME equipment by five assemblers (four car manufacturers and one truck producer) now using such equipment most intensively. This matrix must be regarded as a broad overview of the assemblers' purposes of applying ME equipment. (It was impossible to obtain from individual assemblers any reliable and systematic data on actual extent of application of such equipment.) The matrix suggests (at the points where at least two assemblers score an average rate of 4 points or more) that the use of ME equipment by these assemblers in Brazil aims at:

a) greater flexibility in production facilities;
b) better quality (and more strict quality control);
c) better control of production flows;
d) better working environment (including safety);
e) speed-up of production (productivity).

In only two activities (controls in general and continuous welding) skill saving has motivated assemblers somewhat strongly to use the new technology. What is more, saving in labour costs is not an important reason for the introduction of the ME equipment. This seems to be verified in the light of the following exercise which is intended to give a broad idea about the pay-off period of a robot in painting and spot-welding in the Brazilian automobile industry [(3)].

The basic simple formula is $P = \frac{I}{L-E}$, where

P = pay-off period
I = cost of buying and installing a robot
L = labour savings by the introduction of a robot
E = maintenance costs.

As regards painting, a "Nordson Robot System" has an estimated cost of US$110,000,[3] which, multiplied by 1.5 to account for installation and working costs, gives us the value of I. E was estimated at US$4,500. As reported by user firms, one robot replaces two workers who earn two minimum wages per month per shift. Data on wages supplied by four assemblers is summarised in Table 5. On this basis, the annual labour cost saving is

Table 5

Wages in Auto Assembly in Brazil without Fringe Benefits, in US$/Hour*

Job	Estimated average wage	Minimum average reported	Maximum average reported
Painting	0.98	0.69	1.23
Welding	1.08	0.90	1.23
Tooling	1.68	1.40	1.90
Mechanical Maintenance	1.36	1.27	1.40
Electrical/electronical maintenance	1.75	1.26	2.69

* Calculated at the exchange rate of Cr$1.311,00/US$1.00 as of March, 1984; the salaries indicated are those prevailing in March 1984, and not a yearly average. This remark is important in view of the distortions caused by high inflation in the country.

estimated at US$2,430 per worker per shift. The pay-off period would thus be:

$$P = \frac{110{,}000 \times 1.5}{(4 \times 2{,}430) - 4{,}500} = 32 \text{ years}$$

As for spot-welding, the robot was estimated to cost US$50,000 and double shift workers in welding earn 2.5 minimum wages/month. The pay-off period would be about 10 years, i.e.:

$$P = \frac{50{,}000 \times 1.5}{(4 \times 2{,}040) - 4{,}500} = 10 \text{ years}$$

The obvious conclusion stemming from the foregoing examples is that for sheer economic reasons concerning direct labour costs and fixed capital costs, robots of this type will not be used in Brazil in the near future. Yet, the exercise must be viewed with caution, as the wage figures used might be underestimated by about 50 per cent nowadays, due to the high inflation rates prevailing in the country. It is clear, however, that in face of the wage figures shown above, the pay-off period of this equipment would be much longer in Brazil than in Europe, the United States or Japan.

One might argue that, in the future, wages might rise substantially in Brazil and change the current conditions, but there is no such trend in sight for the time being. Many contraditory factors should be taken into

consideration in making a more substantive analysis. For example, the very savings in labour costs may not derive strictly from the direct use of the equipment, but rather from gains in the factory's overall productivity. Moreover, in general terms, there are important social, political, and cultural factors - and even some macro-economic implications - the evolution of which is difficult to predict.

III. Auto-parts Manufacturers and ME

1. The structure of the auto-parts manufacturing sector

There are over 1,600 parts producers in Brazil, out of whom over 600 are associated with SINDIPECAS. The latter are mostly large firms which supply parts directly to assemblers. A vast majority of them is concentrated in the Great Sao Paulo area, where most assemblers are also located.

These firms are certainly smaller than assemblers, but as a whole they employ about twice as many workers as assemblers do (see Table 2 above). In terms of sales, their market consists of different segments as shown in Table 6. The intensity and form of competition vary considerably from one segment of the market to another. Many firms produce not only auto-parts but also other products. Firms often supply to more than one assembler. To a certain extent, this discourages assemblers to grant direct financial and technical support because they are afraid that their competitors might indirectly reap benefits from such support. This is also part of the explanation for non-existence of "just in time" (Kamban) system involving subcontractors. Recently, auto-parts manufacturers have been concerned about an increasing degree of vertical integration by assemblers, as a result of the "world car" programmes. The asemblers' share in the total shipments by the local auto-parts manufacturers declined from 70.7 per cent in 1978 to 59.9 per cent in 1982. In the meantime, the decline in automobile production in 1981 caused dismissal of about 81,000 workers in the auto-parts sector against 29,000 at the assemblers' plants (i.e. nearly three times more).

The crisis has affected different segments of the sector in different and often contradictory ways. It sometimes acts as a deterrent, but at times it provides - directly or indirectly - the stimulus to investment in new technologies. To begin with, the reduction in the assemblers' orders has left much unused capacity, some of which had not even been paid off, a fact that is detrimental to new investments. Credit has been restricted and interest rates raised. This gives rise to two major consequences. Larger firms are more likely to overcome financial constraints than smaller ones, and foreign

Table 6

Auto-parts Sales by Type of Market

Type of Market	Average: Dec.81/Nov.82
Manufacturers of vehicles, tractors, motors and components	60.0%
Exports	4.0%
Replacement market	28.0%
Others	8.0%

Source: SINDIPECAS em Notícias, Feb. 1983.

subsidiaries are more likely to obtain financial support either from their principal forms or from the international banking system. The smaller local firms are severely affected by the shortage of working capital and high interest rates. We have detected a serious concern that the sector may thus become more denationalised through the acquisition of local firms by already established foreign subsidiaries.

Another factor acting as a handicap to smaller local firms is the difficulty in complying with one of the basic BEFIEX requirements for export incentives. Because of their weak international links, these companies (in contrast with foreign subsidiaries) cannot guarantee a minimum level of exports for long periods of time: "In the first place, the auto-parts exports strategy has been characterised by the exploration of niches in the Latin American market. The commitment concerning pre-established export levels for long periods, as required by BEFIEX, was improper for firms which utilised the external market as an alternative, given the high instability of that market. Engagement in these programmes seemed restricted to foreign firms, who could ensure quotas in their countries of origin, depending on the strategies of expansion of those firms at the world level, or confined itself to large national companies already articulated with the external market. Second, participation in BEFIEX's programmes was discouraged by the high level of investment previously made in the sector in the early seventies" [(7)]. The BEFIEX programmes permit cheap import of modern equipment and thus accelerate the diffusion of ME equipment. This also tends to increase imbalances within

0643e

the sector. Some local firms have been trying to overcome their handicap through the establishment of joint ventures.

Exports of auto-parts increased from US$165 million in 1974 to US$826 million in 1981, and decreased by 10 per cent in 1982 (Table 7). Although they represent only 4 per cent of the sector's sales in 1982 (Table 6 above), they are certainly a promising option for larger firms and foreign subsidiaries to maintain higher rates of capacity utilisation.

Table 7

Auto-parts Sales and Exports

(in US$ millions)

Year	Sales*	Exports**
1974	2,504	40,4
1975	2,707	43,2
1976	3,186	55,9
1977	3,379	82,5
1978	4,447	127,7
1979	4,967	166,6
1980	5,464	211,1
1981	5,116	206,0

Sources: * SINDIPECAS
** CACEX

2. Diffusion of ME equipment

The drive toward exports as a way out of the crisis is surely a factor that accelerates the introduction of ME equipment, since quality standards, production flexibility, and efficient organisation are decisive requirements to enable them to face international competition. In 1971 auto-parts producers in Brazil exported to 33 countries (82 per cent of the total amount to 4 countries). As of 1980 auto-parts were exported to 114 countries (and only two producers accounted for more than 10 per cent of the total exports [(16)].

The growing importance of foreign markets and the release of "world cars" stimulate the sector's modernisation not only in production, but also in

design capacity. CAD has already been introduced by a few firms and others are seriously considering its introduction in the near future, although the engineering designs of "world car" parts are not prepared by local parts-producers, but received from assemblers.

The assemblers' policy of reducing inventories has also been encouraging introduction of new technologies into the auto-parts sector. While the market for automobiles continued growing, orders were given to parts-manufacturers six months in advance and confirmed one month prior to delivery. Nowadays, however, orders are very erratic. They are generally confirmed with a week's notice, but one-day notices are not altogether uncommon (suppliers complained bitterly about this). A few of the larger firms and foreign subsidiaries, along with some of the assemblers, have been studying the possibility of establishing direct inter-computer placement of orders so as to increase the efficiency of production integration (though no actual move in this direction has been made as yet).

The need to assure uniformity of quality and respond quickly to modifications to orders (both regarding quantity and specifications) is definitely a powerful factor inducing auto-parts makers to adopt more flexible and efficient production methods, i.e., ME equipment. A member of the Board of Directors of Abimaq (the Brazilian Association of Machine Industries) mentioned that most inquiries about this type of equipment received by Abimaq members come from the auto-parts sector.

Parts-makers almost exclusively working for truck assemblers have an additional reason for using NCMTs, viz. the low volume of production. Moreover, their products are often subject to modular variations in the same basic truck models, thus facilitating automation. Two axle producers who use large numbers of NCMTs do not employ them in tooling, but rather use them as production machines in ingeniously integrated flexible systems.

In the light of information originating from various sources, at least 50 parts-makers were using over 150 NCMTs, which if added to NCMTs used by car and truck assemblers account for about 20 per cent of the total stock of NCMTs in Brazil (some 900) at the time of our survey. They are used mostly in tool rooms, but a larger number of such machines are used for low volume production than in the assembly sector. Two-thirds of them had some foreign capital participation and about 50 per cent could be considered foreign-owned (i.e., a participation of over 50 per cent by foreign capital). The 14 respondents to our questionnaire reported 71 NCMTs, out of which 62 per cent were lathes and 17 per cent were machining centres (see Table 8).

Our findings summarised in this table are consistent with the general pattern of diffusion of NCMTs in Brazil. In a questionnaire survey in 1983, 73 per cent of the NCMTs were used by firms with 500 or more workers, and 69 per cent of the sample firms in this size group used NCMTs. Eight out of the 10 largest firms (in terms of gross operational revenues) were NCMT users [(6)]. Similarly, in the author's previous study, 66 per cent of all users (76 firms) employed over 500 workers and 62 per cent were foreign-owned [(15), pp. 11-12]. Not only can they better afford to purchase such equipment than smaller firms, but they have also better knowledge about technological developments elsewhere.

None of the parts-makers in our survey expressed an intention of using robots in the near future. Labour costs are too small a proportion of total production costs to justify labour substitution by robots where they might be technically suitable (as is clearly the case, for instance, in loading and unloading, tool changing, etc.). Direct labour costs ranged from 4 to 25 per cent of total costs in the firms visited in the sector. The drive towards ME

Table 8

NCMT Utilisation by Firm Size and by Type of Equipment

(number of units of machines)

Size of firms (no. of employees)		Lathes	Machining centres	Others	Total No. of units	Total %
Below 100	(1)	1	--	4	5	7.0
100-499	(4)	10	3	1	14	20.0
500 or more	(9)	33	9	10	52	73.0
TOTAL	(14)	44	12	15	71	100.0
	%	62.0	17.0	21.0	100.0	

Note: The figures in the parenthesis indicate the numbers of sample firms in individual size groups.

equipment arises far more markedly from the need to increase the flexibility of production facilities to supply parts of different models to different clients in time and with the necessary quality (for both local and foreign markets).

The firms using equipment were far more heavily engaged in international operations than the sector as a whole: 25 per cent of their production was exported, as compared with about 4 per cent in the sector as a whole. Their production for the replacement market stood at 35.5 per cent at the time of our survey, whereas that for assemblers had decreased to 38 per cent. These findings seem to suggest that firms aiming at the foreign market are really introducing new technologies. (The increased importance of the replacement market may be interpreted to some extent, as a cyclical phemomenon related to the current crisis.)

Motivation of introducing new technologies is in line with all that has been stated so far: quality control, flexibility in production, and the characteristics of certain products (Table 9). As for assemblers, they have not played any direct part in this decision. The need to increase

Table 9

Motivation of NT Application

Criterion	%
Quality improvement	34.4
Production flexibility	33.0
Competitiveness	32.7
Work which is difficult or impossible with conventional machines	27.5
Unit cost reduction	25.6
Control over the production process	25.0
Scarcity of skilled labour	9.0
Foreign market requirements	3.0
Assemblers' requests	1.0
Other	7.2

Notes: 1. The number of sample firms = 14.

2. Each firm gave more than one answer.

Table 10

Major Obstacles to the Diffusion of New Technologies

Obstacles	Number of replies
High price of the equipment	14
Brazilian economic crisis	12
Low labour costs	7
High social costs of automation	3
Poor technical assistance	3
Low quality of locally produced automated equipment	1

Note: The number of sample firms = 14.

competitiveness, the need to reduce unit costs, and the need to control the production process were also among the most frequent considerations, although they are obviously overalapping (Table 8). Contrary to the reasonably well established view, the scarcity of skilled labour was rather played down.

Although the initial investment required for the introduction of ME equipment is large, unit costs decrease because better planning and control of the production processes reduce idle labour and the downtime of equipment. Moreover, a wider range of products can be produced, their quality is improved, a greater production flexibility is achieved, and delivery time is shortened, thus rendering the investment in NCMTs very efficient and increasing the competitiveness of the firms. All our respondents intended to buy additional NCMTs (50 per cent had a plan to do so next year), giving material indication of how satisfied they are. However, half of them had not made any a posteriori economic study to confirm the advantages of the new equipment.

As pointed out earlier, assemblers have not interfered in the auto-parts producers' decision to automate their plants. In reply to a specific question whether they had received any financial or technical support from assemblers regarding NCMTs, all the firms gave a negative answer. The only exception was a company which acknowledged some aid received in the form of courses and technical information.

Main obstacles to the diffusion of ME equipment in the near future seems to be the high cost of ME equipment, the country's economic crisis, and low labour costs (see Table 10).

IV. Impact on Employment and Labour

1. Employment impact

No solid data base exists to permit a systematic evaluation of the impact of the diffusion of ME technologies upon employment in Brazil. However, the creation of the Special Commission for Manufacturing Automation (CEAM) by the Special Secretariat for Informatics (SEI) at least shows the Government's concern about the matter. The reports [(4)] prepared by its subcommittees contains two tentative estimates of the impact of new technologies on employment in Brazil by 1990 [(4), p. 15]. One of them, prepared by J.C. Peliano [(12)], suggests that 800,000 to 2,400,000 jobs may be lost in Brazilian manufacturing industries during the forthcoming period. This estimate is based on the highly questionable assumption that the ME automation process of this country will follow the same pattern and pace as the recent forecasts by the Carnegie Melon Institute expect in the American industry during the same period. More realistic is the study by S. Rocha [(13), p. 5] which considers the three different possibilities regarding the rate of diffusion of ME. Assuming a total stock of equipment (NCMTs, robots, and CAD systems) at 2,000, 10,000 or 40,000 units in 1990, Rocha estimates the corresponding range of variations in job positions in the order of 4,000-16,000, 20,000-80,000 and 88,000-352,000 positions, respectively.

The only empirical data on labour displacement due to the use of NC equipment in Brazil that is quoted in that report was drawn from a study conducted by the present author [(15) and (16)]. The data obtained for the diffusion of 700 NCMTs in Brazil by 1980 suggests that there was a net direct loss of 2,000 to 4,800 jobs out of a total between 4,200 and 7,000 positions affected (between 48 per cent and 69 per cent). Those jobs, however, may have been partially recovered by other indirect (and unmeasurable) effects. These proportions are stricter than the range recently made available by the International Metalworkers Association, which places the loss somewhere between 23 per cent and 70 per cent.

Findings of that study of the author appear to be relevant also to the Brazilian automobile industry. For example, our questionnaire and visits in this industry have confirmed that to various companies each NCMT replaced, on an average, 3 to 5 conventional - and general-purpose - machine tools. The majority of NCMTs in Brazil are still attended individually by a worker. They have replaced non-automatic machines. Thus, the use of about 190 NCMTs (150 in the parts-manufacturing sector and 40 in the assembly sector) must

have replaced between 570 and 950 conventional machine tools, and caused a loss of approximately 1,140 to 1,900 conventional machine operators' jobs. In case the proportion between activities directly related to the use of NCMTs is maintained (in that study, the author found 2,200 new jobs created at the shop and in the office), only about 600 new job positions will have been directly recovered within the industry, including about 380 NCMT operators and about 220 programmers and other ME staff. Of course, there are some counterbalancing factors which are very difficult to measure (such as the increase in the competitiveness of user firms and the creation of job positions by the local producers of the equipment), and which should be taken into account in a more precise assessment of the overall net effects on employment.

In so far as one can tell from Table 1, the productivity of labour in the assembly sector measured in terms of the number of vehicles produced per worker in 1983 was below the level achieved in 1975, although it was higher than in 1981 and 1982. The volume of employment in the industry including the parts-manufacturing sector fluctuates with the level of vehicle production. In the parts-manufacturing sector, it must have been affected also by the declining local content ratio of the Brazilian automobiles, although no quantitative assessment has been attempted yet.

Clearly, the current amount of technological unemployment in Brazil is, if any, marginal as compared with that of conjunctural and structural unemployment. Under the circumstances, it is understandable that Brazilian workers give a low priority to technological issues as discovered by a study conducted in early 1983. For this study, DIEESE distributed 19,500 questionnaires among metalworkers at 21 firms in Santo André (part of the Great Sao Paulo area). They got replies from 12 per cent of the workers. We had access to the raw data relating to workers of five auto-parts firms. Control over mechanisation and robotisation ranked lowest among six choices presented to workers as the slogan for the 1983 wage campaign, attracting only 3.8 per cent of the replies. Their main concerns were: job stability (31.8 per cent), union representation within plants (26.2 per cent), and workers' commissions which are intended, among other things, to improve working conditions at the workshop level (19.3 per cent).

The fact is that, so far, the Brazilian working class has not even had a chance to become thoroughly familiar with the dynamics of an industrialisation based on conventional electro-mechanical equipment and already faces a new change in the technical basis, brought about by the diffusion of ME. The local working class appears to be shocked by the new

horizon opened up by the new technologies, and in early 1982, for the first time in their history, Brazilian unions did include technological issues - workers' protection from undesirable effects from technological progress; job stability, guarantee of retraining, etc. - in their agenda of negotiations with employers, who immediately dismissed the subject without offering any alternative proposals.

We have had several contacts with unions and representatives of factory commissions. Virtually all of them were very concerned and anxious about the consequences of the introduction of ME equipment, but did not understand its rationale and had done nothing to monitor its consequences. The only exception was a factory commission which was planning to analyse the labour content of the prodution line related to a model of vehicle which had gone out of production two years earlier, and compare it with the one related to a new model released at about the same time. The assembler had not only refused to cooperate but regarded it as an attitude of antagonism on the part of the workers. Nonetheless, other factory commissions and unions intend to make similar attempts shortly.

It is our understanding that the creation of CEAM was aimed at promoting harmony in industrial relations, as stated in the following recommendation included in ther report:

> "The intensity and rhythm of NT (new technology) adoption should be adequate to preserve mastery over the production processes that are altered and over technological memory, to minimise the foreseeable negative effects on labour, and to reduce the impact arising from the increase in technical efficiency upon inter-industrial relations" [(4)].

The report's major suggestions concerning employment are: (a) strengthening the programme of retraining, vocational training, and education in general; (b) raising of the minimum age limit for entry into the labour market; (c) guaranteeing that labour will not be displaced at least for a certain period after the introduction of new technologies; (d) improving the Government's commitment to the social security policy related to unemployment and other negative effects that may arise from the adoption of ME equipment including creation of an unemployment insurance scheme; (e) strict control over extra working hours; (f) reduction of the working day; and (g) sharing of productivity gains with workers.

The report further suggests that labour legislation be modernised to satisfy all parties involved, and that, at the company level, some form of workers' participation be created to work out the inevitable problems created

by new technologies. Specifically, workers' participation should cover (a) the control over the rhythm and intensity of the work pace; (c) the work environment; (c) job structure; (d) the access to information about equipment, processes and data that interfere in workers' activities.

CEAM's report is a sort of declaration of intents which may or may not be realised, but it reveals how much of a social infrastructure is missing to avoid possible harmful consequences of the diffusion of ME technologies.

2. Effects on work organisation

New technologies are likely to produce organisational changes. Eight out of 14 auto-parts producers who responded to our questionnaire had expanded or created new departments (e.g. programming, maintenance of electronic components of their equipment, NC tooling, etc.) in their plants, and most firms are equipped for their own programming and maitnenance.

All the firms visited as well as those which replied to our questionnaire, stated that NCMT operators and programmers were selected from among their own personnel. Over half of these firms pay higher wages to NCMT operators than to operators of conventional equipment. At the same time, workers become more formally trained, thus paving their way for making a career from the shop floor into the office. On the other hand, ME-based automation increases the possibilities of moving planning and control away from the shop, perhaps eventually moving control to offices located at very great distances, such as a different state or even a different country, which has profound implications for the international division of labour.

Thanks to the systemic nature of their technical knowledge, new production workers have been able to use it as a skill for planning the process formally. In Brazil, it is not uncommon to find programmers who were formerly NCMT operators, and a considerable number of programmers we met were studying engineering (or they were already engineers). In the meantime, computer programming is becoming part of routine work although only about 20 per cent of our respondents indicated they were doing it.

In terms of the skill requirements and prerequisites for operating NCMTs, preferences were divided between opposite extremes: some firms preferred newly trained young workers who might quickly get used to the new technical culture, while others would rather choose workers with a long experience with conventional machines, to entrust with expensive and strategic equipment. There seems to be some sort of barrier in re-training older workers to operate new ME equipment. In many cases, however, these workers' practical experiences remain valuable assets of the firms.

V. Summary and Conclusions

The Brazilian industralisation in the last 30 years or so has been largely stimulated by the establishment of a local automobile industry, which induced development of other industries through linkage effects. The Government decisively supported it by creating the basic material infrastructure necessary for its development.

The central argument of our study is that the Brazilian automobile industry seems to be on the verge of new and major restructuring in which internationalisation of its market and supply base will proceed hand in hand with the transformation of its technical basis. The dynamics of the world's automobile industry, as well as the current conditions of the Brazilian economy, is the main driving force behind such transformations.

The leaders of the world's automobile industry are currently engaged in a process of intensified competition where ME technologies are becoming deadly weapons, eroding and "transforming the basis of the international division of labour in ways which have the most serious consequences for the periphery" [(10), p. 7].

The current economic crisis has caused a slump in car sales in Brazil and a consequent rise in unused capacity. Competition has therefore increased, and the automobile industry has been forced to reorganise and modernise itself, entering a new phase of its development. Exports have received greater emphasis both as a way to decrease the unused capacity of firms and as a means to help overcome the country's deficit in the balance of payments.

Gone is the time when concerns with costs and overall economic efficiency were played down. In those days, the important thing was to be able to produce. Costs were calculated afterwards. Today, the parameters are the prevailing international costs, quality standards, versatility, and quickness of delivery. If one wants to compete, these requirements must be met. ME equipment has provided Brazilian firms with a convenient means to this end. The assemblers have introduced welding, painting and other robots, as well as NCMTs in their tool rooms. Release of "world cars" has provided, in most cases, an adequate opportunity for introduction of ME equipment in their production processes. In the auto-parts manufcturing sector, the most commonly used ME equipment is NCMTs. Programmable controllers and CAD systems are also beginning to be introduced. However, we discovered no plan to introduce robots in the auto-parts sector in the near future.

Partly because of the still very modest extent of application of ME equipment - fewer than 20 robots and about 190 NCMTs - in this industry, the amount of labour displacement caused by the new technology appears, if any, marginal compared with the enormous amount of structural and cyclical unemployment caused by the general depression of the economy. To illustrate this, it may be pointed out that the annual numbers of vehicles produced per worker in 1980-83 were below the level of 1975.

Workers' unions have just begun to voice their concern about (potential) employment effect of ME technolgies. The issue, however, still receives a very low priority in their agenda of negotiations with employers, in the face of the overwhelming impact of the current economic crisis.

The Government is concerned with the socio-economic implications of the diffusion of ME technologies in two ways. On the one hand, it is worried about possible negative employment and other effects and exploring means to overcome them. On the other, it is trying to promote local - and indigenous - capacity to design and produce ME equipment.

In this effort, Brazil is in a serious dilemma. The drive towards automation and the utilisation of ME technologies have been hampered by the Goverment policy to protect the national capital goods industry and by the red tape. There have been general complaints about that. The complaints seem often valid as regards, for example, the inability of the Government to distinguish what is important to protect (or forbid the import of) from what is not. Production facilities sometimes remain idle for long periods because of the difficulties in replacing a one-dollar ME component. On the other hand, if no protection existed at all, the whole long-term strategy of building local capacity to design and produce ME equipment might come apart once and for all. Apart from such long-term macro-economic argument, there is a more immediate micro-economic dilemma: if there is a danger that excessive protection may hinder the adoption of the latest technologies, thereby reducing the competitiveness of local firms, there also is the fact that, without protection, some of the national firms are sure to be killed by international competition even before birth.

Notes

1 (Editor's note): On the concepts of the "just-in-time (or Kamban) system" and Quality Control (QC) circle", see Susumu Watanabe, "Micro-electronics and employment in the Japanese automobile industry", World Employment Programme Research Working Paper WEP 2-22/WP.129 (Geneva, ILO, May 1984), pp. 7-9.

2 It is interesting to observe, however, that despite an increasing effort for saving fuel, these models are not necessarily smaller or cheaper (in real terms) than previously existing ones, as might be expected in the light of the slump in the consumption power of the population at large. The fact is that ever more regularly only the upper income stratum of the population is able to buy new cars, which must fit into their pattern of consumption. The threat of oil restriction, and its high price, has been partly overcome by the utilisation of alcohol as fuel. Nowadays, 80 per cent of the vehicles produced in Brazil are alcohol-fueled. By and large, the difficulties in product and process technologies have been overcome, but this has had no major implications for the diffusion of ME devices as yet.

3 This value is given in the "1982 Robotics Industry Director" as a "typical" configuration. It surely includes the cost of motors but probably not tools. In "Industrial Robots: summary and forecast for manufacturing engineers", Tektran Corp., Ill., USA, 1982, p. 96, accessories represent 30 per cent of the total cost of a welding robot amounting to U$160,000 and 24 per cent of that of a painting robot amount to U$110,000.

References

1 APEC, Revista da, 20 June, 1982.

2 Araujo Jr., J.T., "Mudança tecnológica e competitividade das exportaçoes brasileiras de manufaturados (Technological change and competitiveness of Brazilian manufactured exports)", Instituto de Economia Industrial, Universidade Federal do Rio de Janeiro, Working Paper No. 8, (Rio de Janeiro, 1982).

3 Caulliraux, H.M. and Valle, R., "Período de pagamento de um robô: casos (Robot pay-off periods: case histories)", Grupo de Política Científica e Tecnológica (UFRJ), CNPq, Rio de Janeiro, August 1983, mimeo.

4 CEAM/SEI (Special Commission for Manufacturing Automation/Special Secretariat for Information), "Aspectos sociais, econômicos e trabalhistas da automaçao na manufactura (Social, economic and labour aspects of automation in manufacture)", May 1983, mimeo.

5 EXAME: "O impacto do carro mundial no Brasil (The impact of world cars in Brazil)" (Sao Paulo, Editora Abril), 21 April 1982.

6 --- "Melhores e maiores de 1983 (The best and largest companies in 1983)", special issue, September 1983.

7 Gadelha, M.F. and Lobao, R.M., "Estrutura industrial e padrao de competiçao: Um estudo de caso (Industrial structure and patterns of competition: A case study)" (Rio de Janeiro, FINEP, 1982).

8 Guimaraes, E.A.: Acumulaçao e crescimento da firma: Um estudo sobre organizaçao industrial (Accumulation and company growth: A case study on industrial organisation), 1st edition, (Rio de Janeiro, Zahar Editores, 1981).

9 Humphrey, J.: Fazendo o Milagre: Controle capitalista e luta operária na indústria automobilística brasileira (Capitalist control and the struggle of workers in the Brazilian automobile industry), 1st. edition, (Sao Paulo, Ed. Vozes CEBRAP, 1982).

10 O'Brien, P. and Allen, J.F.L., "The international restructuring of the automotive industry", mimeo (draft), August 1983.

11 Oliveira, F. and Popoutchi, M.A.T.: El complejo automotor en Brasil, (Mexico City, ILET/Editorial Nueva Imagen, 1979).

12 Peliano, J.C.P., "Automaçao, emprego e qualificaçao de mao-de-obra na indústria brasileira (Automation, employment and labour skills in Brazilian industry)", (Brasília, CNRH/IPEA, 1983), mimeo.

13 Rocha, S., "Proposta de adendo (Addendum proposal)", Sao Paulo, 1982, mimeo.

14 Sister, S., "Dinheiro mais barato, alias, menos caro (Cheaper money or, less expensive)", Quatro Rodas, February, 1983.

15 Tauile, J.R., "A difusao de máquinas-ferramenta com controle numérico no Brasil (The diffusion of numerically controlled machine tools in Brazil)", Instituto de Economia Industrial, Universidade Federal do Rio de Janeiro, working paper No. 38, (Rio de Janeiro, 1983).

16 —— "Microelectronics, automation and economic development: The case of numerically controlled machine tools in Brazil", Ph.D. thesis, New School for Social Research (New York, 1984, unpublished).

17 Venosa, R., "A estrutura e o comportamento do setor de autopeças (Structure and behaviour of the auto-parts sector), a Fundaçao Getúlio Vargas working paper (Sao Paulo, 1981).

18 Visão: "O grande salto em 25 anos (The great leap in 15 years)", (Sao Paulo), 11 November 1981.

PUBLICAÇÕES DO IEI EM 1984

TEXTOS PARA DISCUSSÃO

	Nº de páginas
42. ARAUJO JR., José Tavares de. Mercados contestáveis e concorrência Schumpeteriana nas economias de industrialização recente. IEI/UFRJ, Rio de Janeiro, 1984 (Discussão 42).	42
43. ALMEIDA, Julio Sérgio Gomes de. A crise no mercado paralelo de letras: causas e consequências sobre a reforma financeirà de 1964-66. IEI/UFRJ, Rio de Janeiro, 1984. (Discussão, 43).	24
44. FIORI, José Luís. Por uma economia política do tempo conjuntural. IEI/UFRJ, Rio de Janeiro, 1984 (Discussão,44).	67
45. PENA, Maria Valéria J. Operárias e Política Operária (1900-1920). IEI/UFRJ, Rio de Janeiro, 1984 (Discussão 45).	21
46. ZONINSEIN, Jonas. Capital financeiro, demanda efetiva e causas da crise. IEI/UFRJ, Rio de Janeiro, 1984 (Discussão 46).	25
47. HOBDAY, Mike. The brazilian telecommunications industry: accumulation of microeletronic technology in the manufacturing and services sectors. IEI/UFRJ, Rio de Janeiro, 1984 (Discussão 47).	69
48. ERBER, Fabio Stefano. The capital goods industry and the dynamics of economic development in LDCs - The case of Brazil. IEI/UFRJ. Rio de Janeiro, 1984 (Discussão 48).	42
49. CASTRO, Antonio Barros de. Ajustamento & adaptação estrutural: a experiência brasileira. IEI/UFRJ, Rio de Janeiro, 1984 (Discussão 49).	19

	Nº de páginas
50. GUIMARÃES, Eduardo Augusto. The activities of brazilian firms abroad. IEI/UFRJ, Rio de Janeiro, 1984 (Discussão 50).	97
51. ARAUJO JR., José Tavares de. Eficiência e acumulação de capital: Notas sobre a hipótese de Hirschman. IEI/UFRJ, Rio de Janeiro, 1984 (Discussão 51).	16
52. ALMEIDA, Julio Sergio Gomes de. Consequências financeiras do monetarismo. IEI/UFRJ, Rio de Janeiro, 1984 (Discussão 52).	52
53. SCHMITZ, Hubert. Technology and labour utilisation in industry. IEI/UFRJ, Rio de Janeiro, 1984 (Discussão 53).	10
54. PROCHNIK, Victor. As possibilidades das empresas nacionais: o caso do cimento. IEI/UFRJ, Rio de Janeiro,1984 (Discussão 54).	35
55. TAUILE, José Ricardo. Microeletrônica e automação: a nova fase da indústria automobilística brasileira. IEI/UFRJ, Rio de Janeiro, 1984 (Discussão 55).	19
56. ARAUJO JR., José Tavares. Comércio exterior e mudança estrutural na economia brasileira: 1970-1983. IEI/UFRJ, Rio de Janeiro, 1984 (Discussão 56).	22
57. CHUDNOVSKY, Daniel. South-South trade in capital goods. The Latin American experience. IEI/UFRJ, Rio de Janeiro,1984. (Discussão 57)	67
58. UNGER, Kurt e KUSHIDA, Sumiko. La estructura industrial y comercial de los Estados Unidos: reflexiones para el estudio de la internacionalización de la producción. IEI/UFRJ, Rio de Janeiro,1984. (Discussão 58)	23
59. ALMEIDA, Julio Sergio Gomes de. As reformas financeiras de 1964-65: Objetivos, rumos e desvios. IEI/UFRJ, Rio de Janeiro, 1984. (Discussão 59).	80

	Nº de páginas
60. TIGRE, Paulo Bastos. Competitividade dos Microcomputadores nacionais. IEI/UFRJ, Rio de Janeiro, 1984 (Discussão 60)	35
61. PIRAGIBE, Clélia Virginia Santos. Competitividade dos equipamentos periféricos fabricados no Brasil - Impressoras. IEI/UFRJ, Rio de Janeiro, 1984. (Discussão 61).	46
62. HAGUENAUER, Lia, ARAUJO JR, José Tavares, PROCHNICK Victor, GUIMARÃES, Eduardo Augusto. Os Complexos industriais na economia brasileira, Rio de Janeiro, 1984. (Discussão,62)	72
63. ZONINSEIN, Jonas. Atitudes nacionais e financiamento da indústria: A experiência brasileira. IEI/UFRJ, Rio de Janeiro, 1984 (Discussão, 63)	50
64. TAUILE, José Ricardo. Employment effect of micro-eletronic equipment in the Brazilian automobile industry. IEI/UFRJ, Rio de Janeiro, 1984 (Discussão, 64)	40