Automation and Labour in the Brazilian Car Industry

*by Hubert Schmitz and Ruy de Quadros Carvalho**

This article analyses the implications of new automation technologies for labour in Newly Industrialised Countries, by way of a case study of the Brazilian car industry. The research revealed no technological unemployment at the aggregate level but labour per unit of output decreased in automated production lines. The share of skilled workers increased mainly due to an absolute increase of maintenance jobs. Skill requirements within maintenance rose. In contrast the share of production workers and their skill requirements decreased. In comparison with car plants in advanced countries, the displacement of operators remained selective, restricted mainly to operations strategic for quality. Integration of line operations, whether carried out by robots or people, increased. As a result, electronics-based automation has not superseded Fordist work organisation but reinforced it. However, due to high costs of interruption, management was increasingly concerned with workers' reliability and sought to stabilise the labour force. These and other results are used to reflect on the differences in automation and labour utilisation between advanced and Newly Industrialised Countries.

I. INTRODUCTION

Micro-electronics has enormously enhanced the possibilities for industrial automation; so much so that automation has become a crucial issue in the

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debate on employment and industrial relations in Brazil. It has been hailed as both the saviour and the devil. Technology suppliers and employers stress the improvement which automatic machinery brings about by raising productivity, taking over hazardous and repetitive work while leaving for workers the more dignified tasks of monitoring and maintenance. The workers and their unions are above all afraid of the loss of jobs and skills and argue that the new machinery does not necessarily mean better jobs. Hence they strive to be involved in the decisions on whether and how to automate. The government itself, while in favour of technological modernisation, is searching for a position on how to deal with the social implications of automation.

Objective and Structure of the Study

The debate so far, while not short of controversy, has been short of information on what is really happening. The objective of this study is to advance our understanding of the labour implications of automation in the Brazilian car industry. Thus we also seek to provide an input into the international debate which, outside the leading industrial nations, is still at a rudimentary stage.[1]

The structure of the paper is as follows. Section II summarises the competitive pressures which arise from recent developments in the international car industry. Section III shows the degree and type of automation that has occurred in the Brazilian plants and sets out the employers' rationale for automation (motives and obstacles). Section IV draws out the implications for the workforce in terms of number of jobs, organisation of work, skills, wages, turnover, working conditions and control; this constitutes the core of the paper. Our main argument is that the new technologies have induced a number of significant changes in the management policy towards labour, but that these changes do not herald a new epoch in labour utilisation. Section V shows how the workers have responded to the new technologies, both individually and collectively. Finally, section VI draws out some implications for government policy.

The Approach

Our research on the car industry was part of a wider project[2] which aimed to assess the socio-economic implications of the new technologies in Brazilian industry; the main emphasis was on the implications for labour. This work was carried out by pursuing two questions. First, what can Brazil learn from the international experience (see Schmitz and Carvalho (eds.) [*1987*])? Second, what is Brazil's own experience with the new automation technologies? This article presents the results of one of the studies which was carried out for this purpose.[3] Before doing so, we spell out four *general* lessons which we draw from the international experience and which are fundamental to the approach adopted in this study.

1. The urgency of research on micro-electronics arises from the recognition that (i) these new technologies have revolutionary characteristics. This is not to say that revolutionary technical change is a new phenomenon. History points to clusters of innovations occurring in the wake of the development of the steam engine, of the electric motor and of the combustion engine. They all had in common their applicability to many sectors of productive activity. They were generic. This is even more so in the case of micro-electronics. (ii) What differentiates the present wave of technological innovations from those earlier ones is that it is occurring in an international economy which is integrated to an unprecedented degree.
2. However, this integration into the world economy and the revolutionary characteristics of the new technologies must not draw attention away from the *time span* over which they are introduced. Indeed the rate of diffusion, while fast by historical standards has been slower than expected. Even in the advanced industrial countries the changes in the utilisation of labour brought about by the use of new automation technologies have tended to be relatively gradual.
3. An explicit recognition of the time frame is even more important in the case of newly-industrialised countries like Brazil. Research must distinguish from the outset between different phases of automation, because (i) micro-electronics based automation is still in its initial stage, (ii) the effects in the period of transition are different from those in the mature stage, and (iii) the period of transition and apprenticeship can stretch over many years. At the same time this stress on transition may turn out to be misleading since those countries may not follow the path of advanced industrial nations but instead reveal a distinctive pattern in the utilisation of the new technologies and of labour.
4. Emphasis on the time span does *not* mean that newly industrialised countries can afford merely to wait and see. What it does mean is that there is some room to manoeuvre, which will, however, quickly evaporate if not used. Responses must be guided by two considerations: (i) the advantages of the new technologies are real; they offer increasing flexibility, improvement in product quality, reduction of working capital (sometimes also fixed capital), reduction of labour inputs and savings in material inputs; (ii) the question for newly-industrialised countries, therefore, must not be whether to automate or not, but at what speed and under what conditions. National governments, national firms and trade unions can shape these conditions and are not entirely at the mercy of multinational companies or foreign technology suppliers.

Sources of Information

For our research on the implications of automation for labour in Brazil, there were three reasons for giving special attention to the car industry:[4] it is at the forefront of the drive towards automation; it is one of the largest industrial employers in the country; it has a highly mobilised and organised workforce. The investigation rests on the case studies of two large car plants which together employed well over 40,000 workers at the time of the research (1985). We denominate them 'Firm A' and 'Firm B'.[5] The diffusion of electronics-based technology within these firms was uneven. While trying to assess the overall changes we focused on the operations in the body shop.

The information contained in this article comes from:

(a) direct observation of production processes; in both firms we had the good fortune to be able to compare the production lines for two models, one line using the old technology and one incorporating electronics-based technology.
(b) 47 in-depth interviews with managers and workers in firms A and B.[6] These included: 25 interviews with managers of all relevant departments and at different hierarchical levels; 22 interviews with foremen, production workers, maintenance workers and representatives of their workers' council (*comissão de fábrica*). Additional interviews were carried out with trade union representatives and experts in the car industry in Brazil and Europe.
(c) collection of quantitative information from the personnel department of both firms, from their industry association (ANFAVEA) and from various government agencies.
(d) related academic and policy studies.

In what follows we provide first a summary of the international pressures for automation in the car industry before examining the Brazilian experience in detail.

II. THE INTERNATIONAL CONTEXT

Why should enterprises in a low wage country such as Brazil seek to automate? In order to understand this we have to map out briefly recent changes in the international automobile industry.

The Japanese Challenge to the Western Car Industry

The mass production of automobiles has a history of almost eight decades. Probably never before has competition amongst car producers been as tough as in the 1980s. Over the 1970s winds of change developed into gales which show little sign of abating or changing direction. They blow from East to

West; they come from Japan. It is breathtaking to witness not only the rate at which the Japanese car industry expanded (see Table 1) but also how production methods were changed. By now they are well-known (see for example, Schonberger [*1982*], Altshuler *et al.* [*1984*], Watanabe [*1984*]) so we merely need to summarise.

The Japanese leap forward in car production was attained through two interlinked innovations. The first one was *organisational*. It sought to reduce working capital by virtually eliminating buffers on the production line and the inventories of parts. The adoption of this 'Kan ban' or 'Just-in-time' system in turn requires tight integration and closeness to the suppliers. It also demands a zero defect policy which was helped by the introduction of quality circles. The principle of no-buffer was extended to manning practices with the drive towards 'elimating any unnecessary work' [*Dohse et al., 1984*].

The second innovation was *technological*. The application of micro-electronics enabled the Japanese to further automate the various stages of the production process and to integrate production with design and marketing through the computer. They also introduced product innovations by incorporating electronic devices and using new materials. As a result of the organisational and technological changes, Japanese car manufacturers were able to achieve a triple objective: reduction in unit costs, improvement in product quality (especially reliability) and greater flexibility in responding to changes in the market.[7]

TABLE 1

WORLD AUTOMOBILE PRODUCTION 1950–80

(MN UNITS)

	1950	1960	1970	1980
North America[1]	7.0	7.0	7.5	7.2
Western Europe	1.1	5.1	10.4	10.4
Japan	-	0.2	3.2	7.0
Other OECD[2]	-	0.3	0.4	0.5
Centrally planned	0.1	0.3	0.7	2.1
Developing[3]	-	0.1	0.6	1.3
Total	8.2	13.0	22.8	28.5

Notes: 1. 1970 and 1980 were poor years, peak output was achieved in 1965 (10.0), 1973 (10.9) and 1978 (10.3)
2. Australia, Yugoslavia and Turkey
3. Only production with over 80% local content

Source: Altshuler *et al.* [*1984*].

The competition in North America and Western Europe fought back. It did so mainly by stepping up automation – so much so that some Western plants are now more automated than their Japanese counterparts.[8] The adoption of 'just-in-time' production has been much slower, not least because it requires an unrelenting discipline from the workforce and is based on almost unlimited management prerogative hardly acceptable to Western trade unions. (The difficulty with the just-in-time system explains some of the failures in the European/North American 'after Japan strategy'.) Also, the Western countries adopted or threatened formal and informal protectionist measures against further expansion of Japanese exports. This induced the Japanese to set up plants in these countries or establish joint-ventures with Western companies [Jones, 1987].

De-maturation of the car industry is the word which has been used to synthesise this worldwide and broad transformation [*Jones and Womack, 1985; Volpato, 1986*]. It means that product and process technologies, management practices and structure of markets have been undergoing a process of continuous and cumulative changes whose results are hard to predict.

The Car Industry in Developing Countries

This de-maturation is transforming expectations about the future of the automobile industry in the developing countries. It was a common belief in the 1970s that the industry would follow the pattern of other mature industries. This meant that an industry with a fully developed technology and a stable market structure would progressively move to developing countries in search of cheap labour, since this was an important component of industrial cost. These prospects were completely changed. Under the new organisational paradigm it is better to locate parts and components production near the final markets. This is not compatible with the idea of global sourcing for a world car [*Jones and Womack, 1985; Hoffman and Kaplinsky, 1988*]. Above all, the Japanese reduced the number of hours necessary to build a car from 250 to 130 (between 1970 and 1981) reducing the labour cost advantages of countries like Brazil, Mexico and Korea [*Jones and Womack, 1985*]. The more production is automated in the central economies the less low wages are attractive *per se*. This made meaningless any strategy of locating production in developing countries in order to serve international markets from a low wage base.

Does this mean, then, that the investment of multinational companies (MNCs) in developing countries will stagnate? We think that this is unlikely to happen since there is another motive for MNC presence in developing countries: the very expansion of their internal markets in a context of relative saturation of the OECD markets and of increasing state intervention in developing countries in order to internalise automobile production.

Let us present some evidence of the dynamism and growth potential of the developing countries' markets. Table 1 shows that while production practically stagnated in North America and Western Europe between 1970 and 1980, it doubled in the developing countries over the same period. In relative terms this means an expansion surpassed only by Japan. If we update the output of developing countries and add imports of built-up cars and assembly kits, this amounts to 3.1 million units in 1985 which corresponds to roughly 10 per cent of the world market of that year [*Jones, 1987*]. The demand forecasts are more expressive. Developing countries are expected to account for more than 50 per cent of the global incremental demand in the last decade of this century [*Jones and Womack, 1985*].

Certainly this can be questioned as evidence for our case, since it corresponds to a demand which is spread over many countries, which cannot all have their own production facilities. We should therefore consider the output per country which is given in Table 2. While these figures do not reflect the most recent rapid expansion of the South Korean car industry, Brazil stands out as the largest Third World producer of motor cars. The bulk is for the internal market. The OECD forecasts an increase of this market to between

TABLE 2
CAR PRODUCTION AND ASSEMBLY IN DEVELOPING COUTNRIES 1960–80
(1,000 UNITS)

	1960	1970	1980	Local content (%)
Brazil	62.2	343.7	977.7	98
Argentina	30.3	163.4	204.4	95
Mexico	24.8	136.7	303.0	60
Venezuela	6.5	48.0	94.0	40
Chile	-	20.7	29.0	40
Colombia	-	7.7	43.0	20
Latin America	123.8	720.2	1651.1	
India	19.1	37.4	30.5	100
S. Korea	-	14.5	57.2	90
Philippines	2.9	7.6	26.6	70
Taiwan	0.4	n.a.	132.0	60
Malaysia	-	7.5	81.0	50
Iran	2.5	31.8	80.0	50
Indonesia	2.0	2.0	41.0	40
Thailand	-	6.6	25.0	35
Asia	26.9	107.4	473.3	
S. Africa	87.4	195.0	277.0	50
Nigeria	-	7.1	151.0	30
Total	238.1	1029.7	2552.4	

Source: Jones and Womack [*1985*].

2.5 and 3.1 million in the year 2000, which is the present size of the Japanese market.[9]

However, such forecasts are problematic. In fact, since 1980 production has not increased. The recession in the early 1980s led to a substantial reduction in Brazilian output and intensified competition amongst the four multinational companies operating in the country. It took until 1986 to get back to the output level of 1980. Hence car firms have sought to escape from the constraint and instability which arises from catering for only one market. In spite of the world recession they managed to raise exports. Further pressure to increase exports came from the government.[10] Due to the foreign debt of over US$100 billion economic policy was dominated by a concern to maximise foreign exchange earnings. Export incentives and government impositions contributed to the increase in exports which now account for well over 20 per cent of output [*Carvalho, 1987*]. Moreover, the industry also diversified its external markets. From a previous exclusive reliance on Third World markets (particularly Latin America) Brazilian car exports also went to North American and European markets.

In order to achieve this the multinational companies adopted more aggressive policies in their Brazilian subsidiaries. Models were changed radically so as to be acceptable in world markets. Thus international product standards were also transferred to the internal market. Change in products implied change in production processes. Car firms made substantial investments to modernise their production facilities. High on their agenda is the introduction of microelectronics based automation which will now be examined in some detail. Before we do so let us summarise this section on the international pressures for automation. The two main points are:

1. Internationally the car industry has undergone radical technical change spearheaded by the Japanese. Unprecedented international competition pushes the technological frontier ever further ahead.
2. While MNCs operate in Brazil primarily in order to cater for the internal market, they are increasingly driven into the expansion of exports. This in turn requires the adoption of international standards in products and processes.

III. DETERMINANTS OF AUTOMATION IN BRAZIL

In spite of international pressures the industry in Brazil does not have to automate overnight. While it is trying to conquer foreign markets, imported cars are not allowed into the country. Life is not therefore easy for car manufacturers; the contest amongst the four producers on the domestic terrain is severe. Still, they have more of a breathing space than their counterparts in Europe or North America where markets are relatively open. Also the lower wage level in Brazil reduces the urgency for immediate and radical technical change.

The purpose of this section is to show briefly how far micro-electronics-based automation has proceeded in Brazilian car plants and to examine both the forces which accelerate this process and those which hold it back.

Diffusion of Automation Technologies

Micro-electronics based automation is still in its initial stage. At the time of the research the situation in our two case study firms was as follows: in Firm A there was only one stage in the production process in which the latest automation technology had begun to 'take over': where the pre-stamped parts which form the body of the recent models are welded together. This meant extensive use of programmable controllers; more visibly, the chassis or body moved from one workstation to the next on automatic trolleys and was welded together by big automatic welding machines or robots. However, most of the welding of parts such as doors was still done manually. Firm B had gone further in the body shop and automated a good part of the press and paint shop. Again the new equipment was introduced with the launching of new models, which shared the plant space with the lines of old models produced in the conventional way. Both firms employed electronics based equipment also in other stages of the production process but used it only in a limited and isolated fashion.[11] The plan however was to step up the pace of automation significantly. Indeed, since then (1985) automation has progressed further. In particular the feeding of parts into the production line is increasingly organised through the computer. But computerised integration of operations across the entire plant has not yet reached a stage where significant systemic gains can be achieved.[12]

Reasons for Automation[13]

The twin question one has to pose is why do these firms automate at all or, conversely, why do they not go further.

While there is no need to go all the way immediately, there is a need to initiate a *learning* process. This will involve learning to operate or monitor electronically controlled technology, learning to maintain and repair it, adapting it to local conditions, adjusting to the increase of skills and power for some groups of workers and the decrease for others, adjusting management strategies. Both our case study firms had consciously initiated this 'apprenticeship' with new automation technologies.

This learning process is particularly difficult because the technologies are not mature. Breakdowns are frequent and repairs or adjustments often require the involvement of the machinery supplier. Curiously enough it was during factory visits and interviews in European plants (in 1985) that we came fully to appreciate how important the relationship and geographical proximity with the machinery suppliers is. It was clearest in the comparison of two plants (both among the largest in Europe). One relied primarily on automatic machinery developed and built 'in-house'. This plant had managed to keep its automated production lines running relatively smoothly. The other plant had to buy in the new technology mainly from foreign suppliers. Sorting out breakdowns was one of its biggest problems. So much so that the viability of the automated lines was in doubt, if not undermined. So why automate at all? Management's answer was: learning; learning to cope with a technological challenge which would not go away. This is precisely what our Brazilian car firms aimed at.

Learning, however, was not their only reason for automating. They were also after more tangible short term results, most notably an increase in *quality*. Indeed, this objective came out forcefully in interviews with all managers consulted. The stress on the need for greater precision, reliability and homogeneity was a direct result of the drive to step up exports and compete in international markets. Such quality improvements are possible with only partial automation and were achieved according to our informants.

The improvement in quality links in with another reason for automation: eliminating hazardous jobs. Certain manual welding and painting operations were physically extremely strenuous and/or dangerous to the workers' health. Where working conditions are that difficult, quality suffers, in particular regular quality is hard to achieve. Automating these operations was a clear priority. In the interviews of course, management liked to bring up the improvement of working conditions as an objective in its own right.

The decision to automate was also influenced by other objectives, but those were of lesser importance and in any case as yet hard to achieve. Speeding up the flow of production (reducing downtime) became possible but it was held back by frequent breakdowns of the machinery.[14] Better control of the entire production process was of great concern to management but a significant advance will only become possible with a fully computerised monitoring system which both firms plan to implement before the end of the decade. Considerations of flexibility seemed to play only a minor part in the decision to automate. Management had a clear view of the potential which programmable machinery offers in this respect, but also acknowledged that this could not be realised with such partial adoption of new technology.

Thus, the extensive discussions which we held with management on the rationale for automation tended to lead to one general conclusion: except for the important improvement in quality there was no immediate return; it was an investment in the future. To be sure, one of the plants had achieved economies in the use of materials which were higher than envisaged but not strategic in the automation decision. In both firms, economies in labour costs were said to be negligible. Indeed, the pay back period on the new investment was alleged to be very long, between 10 and 12 years. One of our co-researchers, however, challenged this assertion. He calculated that, taking into account all improvements, including quality, the pay-back period was closer to five years.[15]

Obstacles to Automation

If this is correct, one has to ask why these firms are not bolder in automating more radically. To understand this one has to consider several factors which act as a brake.

The most obvious one has already been mentioned: low labour costs. A second reason is the high cost of the new equipment. Transport costs and import levies make it at least 50 per cent more expensive than in the advanced countries. Third, maintenance and repair problems were emphasised in one of the enterprises as a factor that slows down the pace of automation. Fourth, the government's technology policy was stressed as a retarding factor in both firms. The importation of all electronically controlled equipment has to be approved by a Special Secretariat (SEI). The policy of SEI is to strengthen the national capacity of producing such equipment. This is of course heavily contested, particularly by multinational firms. While SEI has not and will not entirely prohibit importation, its policy no doubt slows down the diffusion of the new technology.

Other obstacles were discussed with management but were of less importance. At the time of the research each robot brought into the country received a great deal of attention in the media because of fear of the labour displacing effects. Apparently public opinion did not delay the automation decision. Similarly trade union resistance had no such impact. The reverse is also true. Automation was not introduced in order to break the power of labour in the plants, even though car workers are in the forefront of the new trade union movement. In Italy automation was employers' response to labour resistance, but it seems that this played little if any role in Brazil, a view confirmed by the unions.

By way of concluding this section let us emphasise that automation of the Brazilian car firms was not caused in any significant way by labour-related problems, neither by the cost of labour, nor shortage of certain skills, or disputes with labour. Automation, however, did have a significant impact on the utilisation of labour. This was the focus of our study. The main findings are reported in the following section.

IV. IMPLICATIONS FOR LABOUR UTILISATION

Our research found that the situation of the Brazilian autoworkers in the 1980s had changed in some significant ways when compared with the previous decade. Humphrey's [*1982*] excellent study showed that during the 1970s real wages increased little in comparison with the high increases in labour productivity. But wages were higher than in other metal working branches in order to ensure an abundant supply of labour. This was used by management in order to enforce extreme flexibility in labour use and unprecedented intensity of work. Workers' compliance was achieved by threat. High labour turnover was used as a means of enforcing discipline on the shop floor. In recent years management policies towards labour have changed in a number of ways. The purpose of this core section of the article is to bring out some of these transformations.

Before we do so, it is necessary to introduce some methodological considerations. We think that technology has played an important role in bringing about these changes. Yet, in trying to analyse the labour implications of automation we have to be aware that it is not possible to 'isolate' the technological variable. Labour utilisation in Brazil has also been shaped by economic and political change. Moreover, the way technology itself is used is influenced by these factors. We should mention here at least two factors which had an immediate effect on labour utilisation.

First, there have been major *political* transformations in Brazil over the last ten years, particularly in the labour movement. The politics of production at the factory level found by Humphrey in the 1970s were sustained by the repressive measures of military government. The regime's labour policy consisted of persecuting trade union militants, curbing union activities, using a corporativist legal apparatus which denied workers' basic rights and adopting measures to squeeze wages. With the gradual democratisation of the country, the labour movement has gained in strength from a militancy that came very much from below, from the shop floor. Trade unions have been able to gain concessions from employers' federations through strikes and collective bargaining. The car workers from the state of São Paulo were at the forefront of this process, operating mainly through the regional metal workers' union. They also set up workers' councils (*comissão de fábrica*) so as to gain greater influence over industrial relations at the plant level.

Second, there were general *economic* changes in the 1980s which had an impact on labour utilisation. The most obvious one was the recession which hit the Brazilian economy and reduced output and employment levels in the car industry. A related and equally important change occurred in the conditions of competition. In the 1970s the challenge of production had been to produce the quantity required by the market. In an expanding and protected market the companies could afford (a) to adopt a policy towards labour which sought 'compliance by threat' and (b) to 'absorb' the resulting loss in product quality. The challenge in the 1980s is quality and cost reduction. This requires a more positively motivated workforce. In order to achieve this, management has to modify its authoritarian industrial relations approach.

In what follows, we are concerned mainly with the implications of microelectronics-based automation for labour. Where necessary we will make explicit the influence of the above mentioned political and economic changes. However, we will not deal with them extensively since our focus is on the implications of technological change.

Implications for Employment

Recent studies have stressed the loss of jobs in the automotive industry of many developed countries. The OECD reports that since 1979 approximately 300,000 workers have left the industry in the USA, 130,000 in Italy, 180,000 in the UK and 100,000 in France, with little chance of being re-hired [*OECD, 1987*]. In West Germany and Japan employment in the industry has increased modestly despite their good performances in terms of output growth. This is primarily the result of the process of organisational and technological re-structuring we have discussed before (section II).

The Brazilian case is a little different. As can be seen from Tables 3 and 4 *at the present stage of the diffusion of the new technology, there is no sign of technological unemployment at the aggregate level.* The volume of employment has not decreased as a consequence of automation. What really provoked a substantial reduction in employment at the beginning of the 1980s was the recession. In fact, in 1981 employment in the sector suffered a steep fall, following the reduction in output (Table 4, Figure 1). But since recovery consolidated in 1985, employment has increased slightly ahead of output. This is reflected in the indices of labour productivity. With the increase of output they returned gradually to the average numbers of the 1970s. This tendency seems to be congruent with the low degree of diffusion of the new technology at the sectoral level, that is, so far automation has been so concentrated in specific areas of production and/or companies that it has not affected the sectoral employment/output ratio.

TABLE 3

OUTPUT AND EMPLOYMENT OF THE BRAZILIAN AUTOMOBILE INDSUTRY[1] 1970–86

Year	Output (1.000)	Employment (1.000)
1970	416	64
1971	516	70
1972	622	75
1973	750	89
1974	905	104
1975	930	104
1976	986	107
1977	921	112
1978	1,064	124
1979	1,128	127
1980	1,165	131
1981	781	116
1982	859	106
1983	896	104
1984	865	102
1985	967	115
1986	1,057	127

[1] Data refer to the terminal industry (firms which assemble cars and commercial vehicles); they do not include the autoparts industry.

Source: Associação Nacional dos Fabricantes de Veículos Automotores (ANFAVEA)

TABLE 4
INDICES OF OUTPUT, EMPLOYMENT AND LABOUR PRODUCTIVITY IN THE BRAZILIAN AUTOMOBILE INDUSTRY 1980–86

1980 = 100

	Output			Employment			Labour productivity		
Year	Automobile industry	Firm A	Firm B	Automobile industry	Firm A	Firm B	Automobile industry	Firm A	Firm B
1981	67.0	57.4	76.4	88.5	80.0	91.3	75.7	71.4	83.6
1982	73.7	63.0	87.3	80.9	75.4	86.3	91.1	83.6	101.5
1983	76.9	66.3	100.6	79.4	75.3	96.1	96.8	88.0	105.0
1984	74.2	58.7	108.5	77.9	73.6	99.4	95.4	79.8	109.4
1985	83.0	69.6	114.5	87.8	90.0	102.4	94.4	77.3	112.3
1986	90.7	75.5	114.5	96.9	100.9	104.7	93.6	74.9	109.6

Source: ANFAVEA.

However, we have to be cautious with this conclusion, first, because after the investment in automation it takes some time until the full gains in labour productivity can be realised; second, because electronics-based automation has only just begun. Even if the degree of automation of the Brazilian car industry remains lower than in developed countries, we can expect further investments in automation in the next four to five years. The companies which stayed behind will have to modernise their facilities in order to match the product and process standards established by the technologically most advanced competitor (Firm B).

This is why the analysis at the firm level is most useful. It allows us to uncover trends not yet discernible at the aggregate level. If we focus on Firm B, which is the more automated, it is possible to see that from the beginning of recovery *employment has grown at a lower rate than output* (Table 4, Figure 3). It is also true that the recovery of output was faster in Firm B than in the sector. In fact, Firm B's exports jumped from the level of three per cent of total Brazilian exports in 1980 to 12.5 per cent in 1985 [*Carvalho,* 1987]. Its share of the internal market also increased from 14 per cent in 1980 to 20 per cent in 1984/85. Both performances were clearly favoured by the launch of a new model, whose production was partly automated. The quick recovery of output brought a quick recovery of employment, but unlike the sectoral trend the latter expanded at lower rates than the former. This is reflected

FIGURE 1
OUTPUT AND EMPLOYMENT IN THE BRAZILIAN AUTOMOBILE INDUSTRY 1980–86

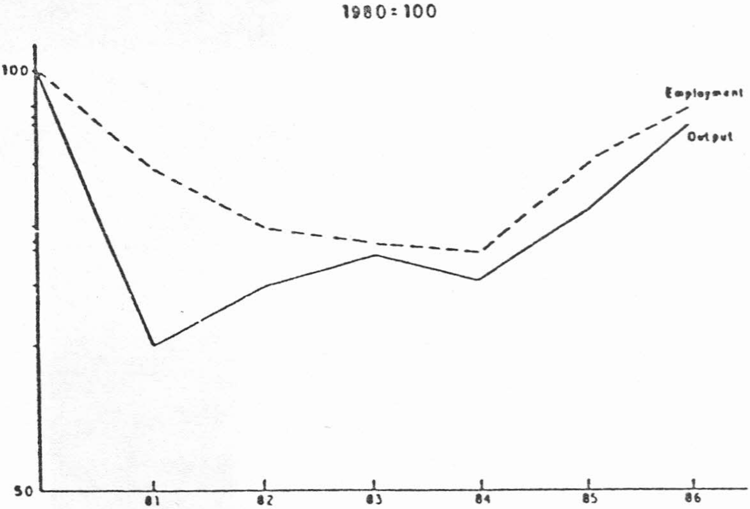


FIGURE 2
OUTPUT AND EMPLOYMENT IN FIRM A, 1980–86

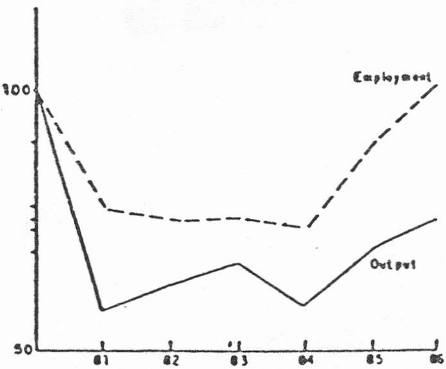
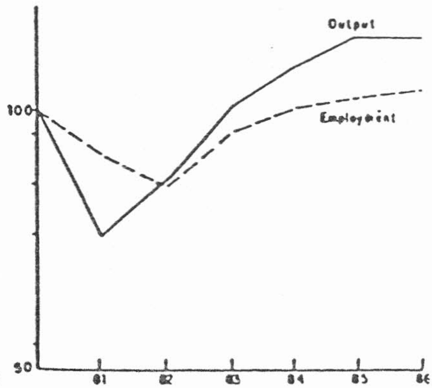


FIGURE 3
OUTPUT AND EMPLOYMENT IN FIRM B, 1980–86



Source: See Table 4.

in the expressive rise of labour productivity until 1985 (Table 4), far above the sectoral productivity increase. It is further evidenced in Table 5, which shows that the number of working hours required for the new model are lower than for the conventional model in all stages of the production process, particularly in the more automated areas. To summarise these points, we can conclude that *automation has been important for the recovery strategy of Firm B, contributing to the expansion of employment, but it has also weakened the dynamism of this expansion*.

The situation in Firm A, which is less automated, is different. Crisis hit this company very badly. It had its share of the internal market reduced from 44 per cent in 1980 to 37 per cent in 1985. The drop of its external sales was even worse. Between 1981 and 1983, the retraction of Firm A's output and employment was more pronounced than that of the sector (Table 4, Figure 2). However, as production levels were re-established in 1984/85, employment also started to recover. In fact, in this firm the rate of expansion of employment has been above the rate of output increase; this is a result of the recovery being based proportionally more in the truck production than in cars. Thus, unlike Firm B, Firm A shows no evidence of weakening employment dynamism as a result of technological innovation. It should be remembered, however, that automation efforts in this plant were restricted to the body frame assembly (welding).

Let us, therefore, disaggregate further and see what employment changes occurred in those sections of the production process where new technologies were introduced. A comparison between conventional and automated bodyframe assembly (welding) in both firms shows a substantial reduction of jobs in the latter, given the same volume of production (Table 6). Again, the case of Firm B is outstanding. In 1985 the bodyframe welding section of the automated assembly line of this company employed 40 per cent fewer direct workers (welders) than the conventional assembly line of an equivalent model for similar volumes of production. This is the result of both automation and the characteristics of the new design which requires fewer spotwelds. It is important to stress that this reduction took place despite the fact that the degree of direct substitution of machines for workers is not very high, due to the selective pattern of automation. The indirect savings, derived from the intensification of work (to be discussed later) are contributing possibly as much as direct substitution.

The trends presented in this section lead us to conclude that to the extent that automation projects, such as those found in Firm B, diffuse more widely within that firm and to other firms, *reduced employment dynamism becomes dominant in the car industry*. For purposes of employment policy this is an important conclusion to bear in mind, since our interviews reveal that the move towards automation will continue in the near future. Automation will progress as the last conventional models are being replaced by new models,

TABLE 5

WORKING HOURS PER UNIT OF OUTPUT ON CONVENTIONAL AND AUTOMATED PRODUCTION LINE IN FIRM B

Production line	Press shop	Body shop	Paint shop	Assembly	Sub total
Conventional	7.5	10.6	5.2	11.6	34.9
Automated	4.2	8.4	3.8	9.7	26.1

Source: Interviews in Firm B.

TABLE 6

OUTPUT AND EMPLOYMENT IN BODY FRAME ASSEMBLY (WELDING) ON CONVENTIONAL AND AUTOMATED LINE IN FIRMS A AND B

Production line	Workers[1]	Output[2]	Workers automated/ line / /Workers conventional line
Conventional A	198	200	83.3%
Automated A	166	200	
Conventional B	362	371	60.7%
Automated B	220	385	

1 Total for two shifts. Maintenance workers are not included.
2 Daily prduction of cars.
Source: Interviews in Firms A and B.

to be produced according to modern techniques. Stamping, welding, painting and testing are the areas of production where automation will probably concentrate and reduce jobs most heavily, particularly those of semi-skilled production workers.

So far, however, the displacement effect has not made much of a dent in the overall employment figures. It has been cushioned by the growth in output which resulted in job increases even for semi-skilled workers. Of special interest is the fact that the number of skilled workers increased over-proportionally. In fact, there has been a very *pronounced increased of maintenance jobs* to which the creation of new occupations has contributed. Such differential growth rates are beginning to change the composition of the workforce.

This is certainly what comes out of a comparison of the number of workers in production and in maintenance in Firm B. Table 7 shows that between 1982 and 1984, the period over which the new technologies were introduced, the proportion of maintenance workers increased. The change is only slight in relative terms, but the absolute numbers are really impressive. In the period

TABLE 7

HOURLY PAID WORKFORCE IN PRODUCTION AND MAINTENANCE OF FIRM B

Area	1982 Total	%	1984 Total	%	1984/1982
Production workers	4,095	91.8	5,127	88.9	1.25
Maintenance workers	368	8.2	639	11.1	1.73
Total	4,463	100.0	5,766	100.0	1.29

Source: Personnel Department of Firm B.

TABLE 8

HOURLY PAID WORKFORCE BY SKILL-LEVEL IN FIRM B

Skill-level	1982 Total	%	1984 Total	%	1984/1982
Semi-skilled	4,010	89.8	5,029	87.2	1.25
Skilled	453	10.2	737	12.8	1.62
Total	4,463	100.0	5,766	100.0	1.29

Source: Personnel Department of firm B.

under consideration, there was a 73 per cent increase in maintenance jobs.[16] Of course, it is possible that some of this growth is due to initial 'teething troubles' with the new technologies.

Since most of the production jobs are classified by the company as semi-skilled and most maintenance jobs as skilled, the above change also suggests that the *proportion of skilled workers increases* (see Table 8). This gradual shift is reinforced by the modifications which this firm made to its job structure as a result of automation. Although the structure suffered no major alterations, all newly created jobs were in the 'skilled' or 'highly skilled' category. Here the most pronounced increase occurred in electronic maintenance.[17]

In order to understand how the skill requirements changed in the various occupations it is necessary to look beyond the numbers and open up the 'black box' of the production process. It means analysing how the labour process changed with the introduction of new technologies and managerial practices. This is covered in the next section.

The Nature of Work and Skills in Production

In the previous section we have asked how the new technologies have affected the number of jobs; the concern was with the quantity of employment. We now enquire into the quality of employment. In this and the next section we ask what the new car workers do and how their skills have changed in production and maintenance respectively. We then pursue this further and ask how the stability of work (labour turnover) and wages have been influenced by the new technologies. Since there is no blind operation of technological forces, the task is to understand how management policy towards labour has been affected by automation.

At a more abstract level, these are questions about the *labour process*; this is the combination of the material instruments of production and the social organisation of labour. A very brief recap of how the industrial labour process developed under capitalism will help us to situate current changes in the car industry. Historically one can distinguish four stages:

1. workers are brought together either under one roof or through the putting out system, without altering the existing technology;
2. the tasks are divided and specialised tools are developed for each operation;
3. this is followed by the development of machinery and the subordination of the worker to the machine;
4. continuous automated production emerges in which the worker's main task is to monitor the machinery.[18]

Ever since Henry Ford introduced the moving assembly line, the car industry has been the most vivid example of stage 3: labour as the appendage of the machine. The moving conveyor resolves technologically a central problem in the organisation of work. It is a means of 'taking the work to the men instead of the men to the work' [*Ford, 1922: 80*]. It provides unambiguous direction as to what operation each worker has to perform, it sets the pace at which the work is to be done. 'The net result is the reduction of the necessity of thought on the part of the worker and the reduction of his movements to a minimum' [*Ford, 1922: 80*].

Until the 1970s the principles of Fordism guided management world-wide in the car industry and in other mass production industries which make discrete products (as opposed to dimensional products, such as chemicals, cement or steel). The 1980s herald a major change. At least in the advanced countries, automation is taking the car industry into stage 4. Our research, however, suggests that this is not so in Brazil. The new technologies (or rather the way they are adopted) seem to push the Brazilian car industry deeper into stage 3. Fordism is being strengthened, not weakened. Let us explain.

We start with the case of the advanced countries. So as not to oversimplify, a reminder: the degree to which operations in the car industry can be automated varies in the different sections of the production process. For instance, according to the production managers of West Germany's largest car plant (interviewed in 1985) they had achieved the following degrees of automation on their most popular model:

press shop	=	90%
body shop	=	80%
final assembly	=	25%

One of the smaller West German car producers had attained lower levels, partly because it was more concerned with flexibility. The approximate figures were [*Koch, 1986*]:

press shop	=	45%
body shop	=	65%
final assembly	=	5%

Our concern here is with the implications for the nature of work (in the jobs that remain) in the more automated sections. To explore these we focus on the body shop, particularly on the weeding operations.

Jürgens *et al*. [*1986: 264*] conclude in their work on 'New Production Concepts in West German Car Plants' as follows:

> The increasing level of automation leads to a corresponding realignment of the structure of work operations from direct repetitive work linked to the time-cycle of the line towards off-line production activities and maintenance work . . . . Welding, soldering, finishing were largely marginalised in the course of the current mechanisation of the body shop. Already, at some firms 95 per cent and more of the welding functions have been automated in the production of standard vehicles. They have been replaced by off-line production activities which require maintenance skills, the monitoring of complex equipment and machine setting.

This is a radical change in the labour process; a move away from a situation in which most workers are engaged in direct handling or processing of products to one in which they are concerned with preparing and monitoring of equipment or intervening in the flow of production when problems arise. Maintenance work increases in importance and becomes more demanding; this point is emphasised a great deal by Shaiken *el al.* [*1984*] in their study on robot welding in a US car plant. The accumulation of different tasks in one job and the need to exercise discretion in non-predictable situations are also reported to feature in the automated sections of car making, according to Coriat's [*1983*] research in France and Italy. He further suggests that the automated production of discrete units is approaching the logic of continuous flow production (see our stage 4). This would mean a shift in the focus of production management; the Taylorist drive of intensification of work is replaced by an all-out concern with the continuous performance of the machines [*Coriat, 1987*]. The logic of automation itself (minimise downtime), the need to adjust the programme of production quickly to changes in demand, and the need to produce to high quality standard have meant a move away from Fordist work practices [*Tolliday and Zeitlin, 1986; Altshuler et al., 1984*]. In short, the suggestion is that Fordism is being superseded in the automated sections of car production.

In this respect, the findings of our research in the welding sections of the Brazilian Firms A and B are significant. They show that, at this stage, *micro-electronics-based automation is not superseding Fordist work organisation but reinforcing it.* In comparison with the more automated systems found in the advanced countries, the new production process of the Brazilian firms presents a lower level of direct displacement of welding operators. However, this selective substitution was accompanied by an increased integration of all welding operations, whether carried out by machines or people.[19] This was achieved by automating the transfer operations. The movement of the parts to be welded together is 'in the hands' of programmable controllers which synchronise operations to an unprecedented degree. Thus jobs have become more machine-paced than before. In short, the basic feature of the new process is the displacement of manual work in certain strategic welding operations and the integration of most remaining jobs into an electronically steered transfer system.[20] As a result Fordism, instead of being overcome, is intensified.[21]

Let us explore the ramifications for the nature of work and skills in more detail. The conventional bodyframe welding process requires special skills which the worker learns on the job. Especially in some critical stages, workers have to manipulate big heavy metal pieces, weld them together using heavy equipment out of very strenuous positions. Doing this work requires a great deal of physical strength and knowing the ins and outs of each operation. This means that there is a certain diversity of welding tasks along the conventional line, but it also means great physical strain and health risk. It is not by chance that the conventional bodyshop is known as 'Vietnam' amongst the workers of Firm B.

The new line does away with the most physically demanding operations. In fact automation was concentrated in those areas, not least because precision and even quality was difficult to achieve with the previous method. The change was welcomed by both managers and workers.

In this process the remaining welding tasks become more standardised. This was perceived as a considerable advance by management. In the words of the manager of the new line in Firm A:

> The new production process has simplified and standardised what workers have to know and do. In the old system some operators end up becoming specialists in certain types of soldering or spot welding

> which are more difficult. On this new line I have more flexibility to change manning, to move operators from one section to another. On the old line, those guys (the specialists) could not be replaced, because it would harm the quality of the product. When one of them resolved to slow down or somehow mess up the production, he had a good chance of succeeding. In the new system, the manual welding jobs are much more standardised. This makes it a lot easier to move people around.

One can hardly resist following this up with a quote from Andrew Ure's *Philosophy of Manufacturers* [*1835*] in which he hails the breakthrough that the application of new technology brings to the politics of industrial production.

> By the infirmity of human nature it happens that, the more skillful the workman, the more self-willed and intractable he is apt to become . . . The grand object therefore of the modern manufacturer is, through the union of capital and science, to reduce the task of his work-people to the exercise of vigilance and dexterity . . . [*Ure, 1835: 20–21*].

Karl Marx could not have agreed more, except that he looked at this question from the labour point of view. In Volume I of *Capital* [*1867*] he recognised very clearly that in as far as machinery dispenses with skills and muscular power, it becomes a means of drawing on a wider range of workers. Machinofacture breaks the limits within which employers can effect a real command over the labour process, hence Marx's (1933) notion of the real subordination of labour to capital. In practice this was given new meaning by Henry Ford, in the way described earlier.

Here we come back to the Brazilian car industry. Our suggestion is that the partial automation of our plants intensified Fordist practices. The simplification and standardisation of work (on the new line analysed above) is one prerequisite for this. The second is the subordination of most welding jobs to the pace of line. Even though each worker can stop the line, the robots act as a kind of pace-maker. In the words of one of the operators: 'Work on this line is more dependent. We are caught, we have to follow the rhythm of the machines. On the other line (conventional) work was heavier, but we could do other things. We had more freedom.' There was a loss of autonomy which mattered to the workers. They were no longer able to plan the use of their time in the course of the day. This came out in many interviews in both plants. Here is just one example: 'The old system had a big advantage. We could store production. We could push hard for some time and then go easy gaining half an hour or twenty minutes to go to the loo or rest. On this new line we have to follow its pace. If it pulls, we go. If it doesn't we stop.' Some, however, made a more ambiguous assessment: 'On the previous line I used to work more slowly. Here the job is easier, but the pace is more intensive. On the old line, I was more in control, but I also worked more because there was more weight to be carried.' As a consequence of both the standardisation and machine pacing of work, labour intensity increased. Since work became physically lighter, production times for each operation could be shortened. Also the porosity of the working day was considerably reduced.

These findings are not unique. Shaiken *et al.* [*1984*] came to a similar conclusion in their study on a US car plant where the degree of automation was higher but had remained uneven.

> The Robogate, respot robots, automatic welding machines, and computer controlled carriers installed in 1980 have fulfilled their expectations – labour productivity and quality have improved, while retooling costs have dropped considerably. The system has also eliminated a number of hazardous and undesirable jobs. For many production workers . . . who remain, however, there has been a significant deterioration in the work environment.
> An intensification of work and an erosion in the quality of life on the job for production workers in the body shop stems from the fact that subassembly jobs are now tied to a line, the subassembly and main frame lines are run faster, and downtime creates stop-and-go pacing outside the worker's control (p.58).

A labour process with these features could be called an 'automated Fordist assembly line' which Coriat (1983) defines exactly as a transitional system. In the case of Brazil this period of transition could well last a long time. The technology exists to automate virtually all welding operations, but with the continuing low labour costs in Brazil, there is no hurry. It seems that the strategic operations vital for quality improvements have been automated. The rest can wait.

If this new labour process has the consequences for the nature of work shown above, we cannot conclude that these are necessary consequences of the new technology. In fact, the new programmable technologies can be used in different ways with different implications for the utilisation of labour and organisation of production. The route taken is a managerial decision and thus a social one. There is no technological imperative. In the Brazilian case management's concern with control was central in shaping the new labour process. The new technologies open up new possibilities of control over production. Management seized upon these for the following economic and political reasons.

As already shown, management uses the new technologies to reduce labour costs by exercising tighter control over how the work is done and at what pace. This represents a loss of power for the workers and an advance for management in the dispute over the control of time. In the car industry this is significant given that its workers are well organised and have – through collective action – gained concessions from management on other issues (see section V). It would be conspiratorial and erroneous to attribute the adoption of microelectronics-based automation to the search for control, but at the same time it would be naive to ignore that management uses it to increase its control over work. However, it is important to remember that the main motives for automation in the Brazilian car industry are (as stated in section III) to initiate a learning process and to pursue an increase in quality. Since labour is cheap, automation is selective. But, in implementing selective automation, management has chosen to organise work in such a way that control over the pace of work is maximised.

The problem is that control can be overdone. The more the workers' room for discretion is reduced, the less interested they become in the job. Negligence or even sabotage may follow. In order to counter this, management advisers in advanced countries advocate job rotation, job enlargement or job enrichment. In the Brazilian car industry such proposals have rarely been seriously pursued. But there is a realisation in management that quality improvement and reduction of downtime require a more positive involvement of the workers. Indeed, the new technologies and competitive pressure are changing management policy towards labour in some ways. Before exploring this in some detail, we should introduce one group of workers which has assumed a strategic importance for the continuity of the new line: the maintenance workers. The changes in the nature of their work and skills are examined in the next section.

Maintenance: The New Strategic Area

If the production workers are losing out in the transition to an automated system, the maintenance workers are gaining. Two observations underline this. First, as already shown, maintenance workers have increased in number, not only in relative terms (proportion of workforce) but also in absolute terms. Second, as will be shown later, management has stepped up investment in these workers through training. The purpose of this section is to show why this is happening. The reasons are fundamentally technology related.

In the case of the new line, the cost of breakages, malfunctioning of equipment and stoppages is higher than on the old line. There are several reasons for this. The number of machines is higher; they are more sophisticated and often fragile (not yet 'mature' technology); incorrectly adjusted equipment leads to the same defect on a large number of products; finally and most importantly, problems in one section can bring the whole line to a standstill, raising the cost of downtime. The high cost of interruption is the new point of vulnerability in production. Hence fast and reliable repair and maintenance has become a priority.

Even though there is now more preventative maintenance, breakdowns are frequent. The interviews with maintenance personnel bear testimony to increased stress due to these technical failures and due to the pressure from management to repair them quickly. The crusade against lost production time is on. One of the workers even referred to it as a 'disease'. Nevertheless the positive aspects of maintenance work on the new line seem to outweigh the negative ones in the view of the workers. They welcome the new technical challenges.

Indeed, what comes strongly out of the interviews in Firms A and B is the *upgrading of maintenance skills*. Contrary to what the international literature suggests this is even true for mechanical maintenance. Mechanics have to be able to digest more technical information, especially in the area of hydraulics and pneumatics. Also, traditional practical skills are important, especially in this transition phase; often they have to copy or adapt spare parts when importation is the only alternative – one that is slow and costly. But the main growth area is electro-electronics. There are new occupations in this field which are more skilled and higher in the hierarchy than those in electrical maintenance on the old line. The new knowledge required is both theoretical and practical. Studying the manuals for the electronic equipment is part of the daily work. Then there is a whole range of new practical activities and skills which make electro-electronics the neuralgic point for the continuous functioning of the line.

In principle, it is possible to separate out the simple maintenance functions and give them to lower skilled people. While this occurred the strategy for maintenance was not based on the Babbage principle[22] and did not lead to a polarisation of skills within maintenance. The pressure to minimise downtime works against it. It pushes in the opposite direction: the integration of skills. This was clearest in Firm B. On the conventional line maintenance work was organised according to area of specialisation. For the new line they were brought together into multi-skilled groups which combined mechanical and electro-electronic specialists and which were headed by an engineer.

Thus it seems that even though automation has only been selective, in one respect the logic of a continuous automated system has already taken over. The pressure to minimise downtime makes maintenance a strategic area and leads to an organisation of work which tends to enhance maintenance skills generally instead of polarising them.

Indeed our findings echo those which Shaiken *et al.* [*1984*] made in a more automated US car plant:

> The advent of robot welders has broadened the skills required of welder repairmen. . .They understand programmable logic controllers. . .as well as repair the more sophisticated conveyors and monotractors that feed parts to the robot welders. To some extent, welder repairmen have taken on responsibilities traditionally handled by basic tradesmen, especially machine repairmen, electricians and toolmakers. Indeed the corporate Director of Manufacturing Engineering regards welder repair as an important part of the company's move to increase productivity through combining classifications [*34*].

In our Brazilian plant these classifications had not yet been combined, but integration of skills into groups is a move in the same direction.

Of course, manufacturers of the new technology are conscious of the need to incorporate automatic diagnostic equipment in order to simplify maintenance. The future will see more self diagnosis and some of it is already happening. Nevertheless our findings are almost identical to those of Senker *et al.* [*1981*] in the British engineering industry, namely almost 'no evidence that any de-skilled task which may be created – such as the replacement of electronic circuitboards – are being separated out into de-skilled jobs. Rather, the need for efficient and quick diagnosis and repair of faults in complex equipment demands that disparate skills be combined' [*34*]. Overall they conclude: 'that the proportion of maintenance craftsmen to the total workforce is likely to rise; that these craftsmen are likely to require a wide range of skills in the future . . . the breadth of skill required of maintenance craftsmen is likely to increase rather than decrease' [*33*].

The need for higher maintenance skills is probably even greater in developing countries. The reason lies in their distance from the suppliers of technologies. This can be a problem even for user firms in advanced industrial countries, but they can rely more readily on maintenance services provided by the supplier of the equipment or specialised repair firms; even if they use primarily their internal maintenance crew, outside maintenance provides an important fall-back position. In developing countries this is extremely difficult, especially with new electronics-based technology.

To be sure, there is no clear-cut division in this respect between user firms in both groups of countries. Adequate suppliers' involvement in maintenance is a problem also for user firms in advanced countries. One such case was mentioned in section III. In turn, machinery suppliers did play a role in maintenance for our case study firms, particularly in the very initial stage, but adequate outside maintenance was not available for the day to day problems of dealing with breakdowns.

Thus it is not surprising that our case study firms stepped up their investment in training considerably. We calculated that Firm B ran internal courses for the maintenance of electronically controlled technology which totalled approximately 2,000 hours. This figure refers to the first two years of automation and covers all production departments in which the new technology was used. Some of the courses were held in conjunction with the state vocational training service, SENAI. In Firm A, which is less automated, the provision of maintenance training is not of the same scale. It is, however, building up a specialised sector for micro-electronic maintenance with a view to future needs; it is an investment made to enable the firm to develop its own training programmes and internalise all maintenance work.

Let us conclude by contrasting the changes in skill requirements in maintenance with those in production. As seen in the previous section, the production work (welding) was standardised. This amounted to a collective deskilling in the sense that the most difficult jobs were replaced by machines.

In the remaining jobs the practical and theoretical requirements remained more or less the same. For maintenance workers, on the other hand, there has been a considerable increase in the requirements for formal knowledge and capacity for abstraction and problem solving. Thus, one can conclude that *the skill gap between the two groups of workers has widened*.

This finding, however, has to be qualified in a number of ways. First, the widening gap is specific to the stage of transition. On a fully automated line the production workers' main task would be monitoring. This results in the blurring of the distinction between production and maintenance.[23] Second, even in its present form the new production process seems to be associated with the increase in formal educational qualifications for all workers involved. Third, there has been increasing involvement of production workers in quality control. This has not been formalised but is expected from the workers. It requires a knowledge of the product and of the production process which goes beyond their immediate tasks.

In fact, this concern of management with quality of the product and the drive to minimise downtime has changed management policy towards labour on a number of other issues. These will be explored in the following section.

Reliability, Stability and Wages

There is a general conclusion which we can derive from the previous two sections. The new technologies drive management into a difficult corner. The same technological innovations which facilitate its control over work make it more dependent on the goodwill of the workers. We have discussed the new strategic role of maintenance workers at some length; also the production workers' cooperation has become more critical. If they push the wrong button at the wrong time or fail to report a faulty part, the repercussions tend to be more severe than under previous technological conditions. Thus the new technology brings to the fore the issue of *trust* and *reliability*.

Dependable work performance can hardly develop (or be assessed) when employment conditions are unstable. Hence one would expect to find a management policy which seeks to stabilise the labour force. Indeed, in Firms A and B, *labour turnover decreased significantly* (see Table 9).

The reduction of average monthly turnover rates is truly impressive.[24] But caution is needed in interpreting these figures. Technology is merely a contributing factor. A major force behind this improvement is the collective pressure from the workers, exercised through their trade unions and workers' councils.

As already mentioned, in the 1970s authoritarianism reigned supreme in Brazilian car plants. Workers' compliance was enforced through the threat of the sack. Foremen and managers used and abused dismissals [*Humphrey, 1982*]. Such practices have been considerably reduced. In the 1980s industrial relations have been characterised more by negotiation between employers and workers. The latter struggled hard to achieve this, and the they succeeded mainly because they applied effective collective pressure [*Almeida, 1985; Leite, 1985*].

However, in our view it is also important to realise that some employers began to recognise that a change in labour relations was in their own interest. We would suggest furthermore that the process of re-building industrial relations in car plants A and B was related to the introduction of new technologies. This came out clearest in an (unsolicited) statement from the head of the Industrial Relations Department of Firm A:

> The orientation of the enterprise is summed up in two principles: honouring the work contract and maintaining employment. There is a connection to the need for a workforce which is dependable, cooperative and stable so that it can deal with the expensive and complex equipment of the type we have in the automated areas.

The 'new philosophy' is also found in Firm B. According to the head of its Education and Training Department:

> The policy of the company has changed since 1980. The concern is to improve the quality of the workforce in the widest sense. Perhaps it is easier to administer a docile, submissive and semi-illiterate workforce. The company has a different policy. For example, it was the first to discuss the setting up of a workers' council. There is a preoccupation with a general improvement and hence also with better formal education.

Another executive of this firm extended this by emphasising that:

> The new philosophy in labour relations has as its pivot trust in the worker. Trust generates trust. The company has to treat the worker well, because the cooperative spirit is what most matters to the company . . . . This period of increasing union demands and of conflicts has improved the relationship with management and paved the way for a process of negotiation.

Such discourse has to be treated with caution, but we came to the conclusion that it was not just rhetoric and that the enlightened managers were gaining the upperhand against the 'hardliners' in their companies.[25]

Of course, the 'new policy' is an old trick in industrial relations: making the worker identify with the enterprise. Our car firms pursued it for a double objective: to take the wind out of the sails of the trade unions and to gain the dependable workforce which is required for the new technology and product quality standards.

One important initiative in this respect was the establishment of quality circles.[26] They had not quite taken off in Firm B, but had come to play an important role in Firm A. The circles have helped to improve product quality but in some cases have also resulted in the rationalisation of work, at times detrimental to the workers' interests. Still, their diffusion occurs in

TABLE 9

MONTHLY RATES OF LABOUR TURNOVER IN FIRM A AND B, 1977–86

	Firm A		Firm B	
Year	Average monthly departures*	Departures / Workforce (in %)	Average monthly departures*	Departures / Workforce (in %)
1977	560	1.43	485	2.14
1978	515	1.36	302	1.42
1979	460	1.12	273	1.26
1980	620	1.43	330	1.43
1981	1,135	2.46	331	1.52
1982	108	0.32	63	0.33
1983	366	1.03	74	0.36
1984	153	0.84	105	0.48
1986	451	0.99	270	1.15

Source: Ministry of Labour (SINE) and ANFAVEA.

* Departures ('Desligamentos') comprise all situations through which an employee can leave the job; dismissal, resignation, retirement and death.

a context of greater workers' involvement. From their participation in the quality circles and the discussion of their work practices, the workers seem to derive a feeling of self-esteem and recognition, which contributes to the creation of a cooperative attitude. The establishment of such circles can proceed independently of the introduction of electronics-based automation, but it helps to foster the dependable workforce which the smooth functioning of the new technology requires.

At the beginning of this section we emphasised that an improvement in workers' reliability requires stability in work relations. Even though the improvement in turnover rates which did occur was not simply technology induced, the result tended to confirm a hypothesis which arose from previous research [*Schmitz, 1985a*] and which found an association between high costs of interruption (in continuous flow production) and low turnover rates.

That research had also revealed the emergence of a reliability wage. The suggestion was that because reliability is of critical importance in automated plants it is efficient for employers to offer their workers a wage package better than that of otherwise comparable workers.

We did not find much evidence for this in the car industry. Our case study firms did not introduce any *formal* wage differentiation for the workers on the automated lines. However, in the case of Firm A we found a subtle differentiation which resulted from the internal recruitment procedure which was adopted for the new line. Both production and maintenance workers were selected from the highest grade within their wage group. Thus, the welders for instance had an average wage which was five per cent higher than that of welders on the old line. According to the manager of the new line a formal and more substantial wage difference would be desirable, but this would have such wide-ranging repercussions for the criteria of wage determination and for the wage structure of the enterprise that it could only be expected to occur with a significant increase in automation. We would add, however, that with more automation internal differentiation becomes a problem in itself. The very technological conditions (especially integration) demand a concern with the collective worker and collective efficiency.

In conclusion, the terms on which workers are employed reflect in some respects (particularly wages) the transitional phase of automation. In other respects (particularly stability) they come close to those found in highly automated continuous flow production. The improvement in the stability of employment is not, however, simply a result of technological conditioning but of the interaction of economic and political factors, particularly increased pressure from workers' organisations. To the extent that the terms of employment are determined by technology, the future direction is clear. Further automation will increase the concern with collective reliability and will exert a downward pressure on labour turnover and an upward pressure on wages.

Automation and Labour Utilisation in Perspective

Is there an overall conclusion one can draw from this core section of the paper which dealt with the implications for labour? We believe that a sober assessment of our research results would suggest that the observed changes are not dramatic. This is a boring point to make in the age of the microelectronic revolution, but it is important to make it. This is not to contradict the path-breaking work of Freeman [*1984*], Perez [*1985*] or others who emphasise the revolutionary character of the new technology. Far from it. We accept and endorse their view that a paradigmatic shift in industrial organisation has become possible with the new technologies. We must, however, emphasise that according to our research the radically new technologies are being used successfully in an incremental way and have not resulted in fundamental changes in the utilisation of labour. Of course the research is only a small case study but it is worth remembering that it has focussed on the two most advanced firms of the largest car industry in the Third World and that the world car industry is at the forefront of the new technological and organisational changes.

However, our emphasis on continuity does not come from a comparison between Brazil and, say, West Germany or Japan. It comes from our previous research on technology and employment practices in Brazil. By previous we mean pre-microelectronics. Most of the technology induced changes which we observed in the car industry merely consolidate trends one could observe before:[27] the reduction in employment growth was clearly discernible but is hardly a new phenomenon. It is well known from, for instance, the last four decades of the Brazilian textile industry. Similarly, the simplification/standardisation of operator jobs which made possible the intensification of work and control is well documented for other Brazilian industries and previous decades. The increasing importance of maintenance workers, the concern with collective reliability and stability are less well known but have also been found previously, most notably in the (continuous flow) production of dimensional products such as chemical fibres, cement and steel. Probably the most significant change is that, with the diffusion of the microelectronics based automation technologies, some of the implications of the reliability factor are also beginning to emerge in the production of discrete products such as motor cars. In terms of our earlier classification of labour processes this would amount to a gradual approximation to stage 4 in at least some respects. However, it is important to remember that in other respects there is an intensification of the already prevailing stage 3. This 'limping' result arises from the selective use of the new technologies.

Whether the future will bring a definite rupture with the past is hard to predict. It could be that the experience we analysed was merely the first step in a countdown for a dramatic increase in automation and that it does not tell us much about the shape of things to come. Our guess, however, is that this is not so, that the hybrid solutions will continue, that what we called, somewhat vaguely, the period of transition will go on for a long time, and that the employment practices we found are far from transitory. Only the future can tell, but never conclusively because technology is not the only influence on the utilisation of labour.

V. THE WORKERS' RESPONSES TO AUTOMATION[28]

From the future we now move back to the present and recent past. How have the workers reacted to the technological innovations introduced by management? In order to answer this question we will first show how workers have reacted as individuals before we deal with their collective responses

Individual Responses

There is no doubt about what was uppermost in the workers' minds when management began to bring in the latest technology. Would they lose their jobs?

At the time of the research there was a lot of discussion of what automation would do to autoworkers' jobs. Some of this was based on rumours that a fair number of them could expect to be fired. However, since the automation was gradual and did not result in massive substitution of labour with machines, workers began to be more relaxed about this technological change; they learned about co-existing with programmable controllers, robots and other automatic equipment. Clearly this was helped by the fact that some of the most strenuous and dangerous jobs were now carried out by these machines. Working on the new (automated) line also seemed to confer a certain status and thus add to the attraction of the new technology. Certainly no act of sabotage to the new machines was registered in either plant, in spite of that spectre of technological unemployment which never entirely went away.

Thus, after an initial uproar, the automation question ceased to be the priority in workers' daily conversations. This is not to say that they did not realise what was going on. They were also quite clear about the future impact of accelerated automation as exemplified by one of the workers interviewed: 'The new technology will open up jobs for some and take jobs away from others. The ones to gain are those who've learnt about the new equipment. As for the rest they'll have to go working in the fields or selling in the streets.'

One question which we thought was important when we started the research was how the new technologies would affect workers' capacity for strikes or other action. Some of the international literature [e.g., *Shaiken, 1980*] suggested that the new wave of automation would undermine workers' possibilities of exerting pressure on management.

Our research does not support this. Neither line workers nor supervisors thought that their capacity for action would be threatened by the new technology, and not just because it had not yet diffused widely. They thought that in some ways more automation would give them greater leverage because of the high cost of damaged equipment or of interrupted production. In our own judgement this seems correct if the dispute is over the terms on which workers are employed. If the dispute is over whether there will be employment at all, that is, over workers management wants to get rid of due to automation, the position of labour is clearly weakened.

Collective Responses

How did the workers' representative bodies react to the new technology? In answering this question it is important to point out again that the car workers are at the forefront of the new labour movement which has developed in Brazil since the mid-1970s (see Humphrey [*1982*]). They are now highly organised. At the sectoral level they belong to the strong metal workers' union. At the plant level they have formed the workers' council (*comissão de fábrica*).[29]

The workers' councils of our plants adopted a position of 'critical acceptance' of automation. Their representatives made it clear that they did not oppose technological progress but would oppose significant job losses. Indeed, the councils fulfill an important role in keeping workers in the picture about actual or potential negative effects of automation. Their strategy is both to provide information and prepare the terrain for mobilisation if this were to become necessary. Their objective is to gain some say over how the new technology is introduced. In fact, in Firm B the council played an important role in negotiating the retraining and transfer of displaced workers to other sections of the plant.

Let us now turn to the position of the metal workers union. Its priorities are *greater job security* and a *shorter working week*. Automation heightened the urgency of both concerns but they had already been high on the unions' agenda before microelectronics hit the headlines.

Job security was a sore point because labour turnover in auto firms had been high in the 1970s [*Humphrey, 1982*] and because the recession in the early 1980s resulted in massive layoffs (compare section IV). By the mid-1980s, however, the reduction of the 48-hour week had become the main object of metal workers' struggle. Strikes, go-slows and negotiations produced first results in 1985 when the norm began to move towards 44 hours per week[30]. For the unions the reduction in the working week has double importance. It may help to reduce the labour displacing effect of automation. It also gives workers some share in the productivity gains. However, as mentioned above, the call for a shorter working week has merely intensified with automation and did not originate in it.

There are union demands which result directly from the introduction of new technologies. One of them is advance notice of further automation. The union representatives interviewed for this research stated that they only learned about the existing automatic equipment after it had been implanted. For them advance knowledge is the key to effective negotiations with employers over the terms of automation.

The main items which unions have tried to force onto the negotiating table are:

- six months' advance notice to be given to the union and workers council;
- obligation of employers to negotiate an innovation plan which maintains the level of employment by redeploying workers;
- guaranteed jobs and wages during the period over which negotiations take place;
- participation of all workers in productivity gains.

Employers' federations refused even to enter negotiations on these items. Some enterprises, however, indicated willingness to have separate discussions with representatives of its workers. This included one of our case study firms which agreed to inform the workers' council of future automation plans and to negotiate conditions of implementation; to what effect remains to be seen.

In conclusion, in their collective responses to automation, workers' organisations have been concerned mainly with job security, number of working hours and wages. It is worth noting that working conditions have not figured. According to one of the managers of Firm B, 'neither the workers' council nor the union are interested in questions such as monotony, eye-strain or loss of skills'. There is a history to this. Trade unions in Brazil have traditionally been less involved in such detailed shopfloor matters. This has not entirely changed. Even though workers' organisations have increased their influence over recent years, the question of pace and type of work remained outside their reach. Probably this also explains why the intensity of work in one of our Brazilian subsidiaries is considerably higher than in the European subsidiary of that company.[31] The role of the trade unions is taken up again in the context of the following section on government policy.

VI. IMPLICATIONS FOR GOVERNMENT POLICY

In this final section we break away from the car industry and its workers and ask what action government should take with regard to the implications of new technologies for labour. Our considerations are brief but may be relevant also to countries other than Brazil.

While the new technologies will not 'bite' overnight and will hit some countries and sectors more than others, there can be little doubt that the economic and social implications are becoming unavoidable issues for many developing countries. To repeat what we said in the introduction, the question is not whether to automate or not, but at what speed and under what conditions. National governments, national firms and trade unions can shape these conditions and are not entirely at the mercy of multinational companies or foreign technology suppliers.

What does this mean for a government that cares about the social implications? Concern with the social implications of new industrial technologies tends to focus on the loss of jobs and skills. Indeed, documenting these changes has been a major objective in our own work. However, even where the effects are negative for the workforce, a political response culminating in a fight against automation would be mistaken. The reason is simple; firms which do not use advanced technologies are in danger of losing hard-won competitiveness and consequently may have to reduce job opportunities. The social cost of not automating may be higher than the social cost of doing so. This is the rhetoric of employers, but unfortunately it is also a fact of economic life – particularly in an era which is characterised by a speed up of technical change and international integration.

Should governments and trade unions therefore leave the management of technical change entirely to employers? Certainly not. From our point of view, the government's main task is to create the political and especially the legal framework in which the trade unions can negotiate the terms on which the new technologies are introduced. Inevitably some sections of the workforce are adversely affected; painless technical change is a myth. The workers' local representation is likely to be the best informed and best equipped body to negotiate conditions which minimise the disadvantages for the individuals concerned. Employers who resist such procedures tend to ignore the fact that an authoritarian approach is less likely to gain workers' active collaboration in the quest for technological modernisation.

In addition to the above 'legal responsibilities' the government (Ministry of Labour) plays a major role in industrial training. Our research revealed the increasing importance and complexity of maintenance work. Occupations such as mechanic, electrician and electronist require a relatively comprehensive training which in its basics is common to all industries. Hence investment in such training does not amount to a subsidy for specific enterprises. The suggestion of more and better government-supported training of maintenance workers receives added weight from the concern with building up an indigenous technological capability in developing countries. The ability to maintain and repair technology is a first step towards the capacity to adjust this technology to local conditions and, at a later stage, possibly replace it with new designs. Let us broaden this point a bit further and locate it in the general discussion of the implications of new technologies for labour.

Concern with the losses of jobs and skills is important, but the displacement effect is to some extent inevitable. From a government policy point of view, a *focus on where the new jobs and skills are created is more important*. One crucial issue here is where the new hardware and software is produced, since it signifies the difference between job and skill creation at home or abroad.[32] These are indeed complex matters of developing indigenous technological capability, but they can be influenced effectively by economic policy. It is certainly not helpful to pretend that a Ministry of Labour (or any of the 'social ministries') can do much about the net employment effect of new technologies. The Brazilian government's technology policy, the protection granted to parts of the electronics sector, is a positive example.

The issue of whether the government should foster a national electronics sector has rightly occupied the centre stage in the 'high tech' debate in Brazil. However, an important dimension is missing in this discussion. The generally nationalist stance of the government is important not just for reasons of economic and political independence, but has also a powerful social rationale: the need mentioned above to internalise the creation of jobs and skills. Technology policy is social policy. Hopefully this is not just a slogan but a consideration which can be given more weight in future research and policy making.

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NOTES

1. Research on the implications of micro electronics based automation for labour is largely confined to developed countries; for a review see Acero [*1985*], Schmitz [*1985b*] and Kaplinsky [*1987*]. Technology related employment patterns in developing countries before the advent of micro electronics are analysed in Schmitz [*1985a: Parts 1 and 3*]; for a review of the recent Brazilian literature see Carvalho [*1987: Ch.2*].

2. We are indebted to George Martine, director of the project, for his enormous support. In the course of the research we received many useful suggestions from Claudio de Moura Castro, Benjamin Coriat, Tom Hewitt and José Ricardo Tauile. John Humphrey and Vera Pereira provided valuable comments on the draft of this paper.
3. Other activities included the participation of José Carlos Peliano in the Special Government Commission on Automation, see Secretaria Especial de Informática [*1984*] and Peliano [*1983*]. For a project report on employment and skill implications in the Brazilian electronics industry see Hewitt [*1986*]. The implications of microelectronics based automation for the competitiveness of Brazilian industry were studied by Tauile [*1986; 1987*]. Implications for trade unions were studied in detail by Neder *et al*. [*1988*].
4. In this article we focus on the terminal industry and do not include the autoparts industry. Technical and organisational change involving the latter is being studied by Annie Posthuma of the Science Policy Research Unit at the University of Sussex.
5. We are grateful to managers and workers of both firms for their generous cooperation as well as to the union representatives. Thanks are also due to CEDEC, DIEESE and ANFAVEA for their support in the fieldwork.
6. For the interview schedules and questionnaires, see Schmitz *et al*. [*1984b*]. These were prepared on the basis of research hypotheses derived from the international literature and our knowledge of the Brazilian situation, see Schmitz *et al*. [*1984a*].
7. These achievements are now well recognised and the new production and management paradigms have found their way into Western schools of business administration. See, for example, Wildemann [*1986*].
8. According to our interviews with plant managers in Western Europe.
9. See Gazeta Mercantil, Relatório Especial, 25 April 1985.
10. For details see Jenkins [*1987*].
11. The other two car producers operating in Brazil had automated less than Firms A and B. For an overview of how far micro-electronics-based technology had diffused amongst Brazilian car and truck assemblers by 1984, see Tauile [*1984*].
12. For a discussion of different degrees and types of automation and the importance of systemic gains, see Kaplinsky [*1984*].
13. For this discussion of the determinants of automation we owe special thanks to José Carlos Peliano who was in charge of this part of our joint research project.
14. In one of the plants we received contradictory information on the significance of this problem. According to the engineering department the new technology worked relatively smoothly; according to the maintenance department this was not so. The considerable increase in maintenance personnel and skills would confirm the latter. For details see section IV.
15. See J.C. Peliano, 'O lamento das montadoras', *Revista Nacional de Telemática,* janeiro 1986.
16. The increasing proportion of maintenance workers is confirmed by Buarque *et al*. [*1984*] who carried out a brief case study of this car firm.
17. A review of the international experience with automation suggests that programming occupations contribute in a similar way to shifts in the composition of the workforce [*Schmitz, 1985b*]. The data made available did not however allow for verification in this case study.
18. The first three stages represent the account given by Marx [*1867*]. A fourth stage, we believe, has to be added, because of the degree of automation achieved and the implications for the utilisation of labour. However, such a fourth stage does not herald the end of alienation. On the contrary, far from bringing to an end the real subordination of labour, automation technologies tend to increase employers' command over the labour process. At the same time it is true that the rhythm of work is no longer tied to the rhythm of production and that workers have different functions resulting in different employers' policies towards labour. For details see Schmitz [*1985a*]. See also our later discussion in this paper on reliability and stability.
19. In the case of Firm B, this sort of integration was also found in the new press and paint shop.

20. A detailed comparison of both the old and new body shop in Firms A and B can be found in Carvalho [*1987*] and in Peliano *et al.* [*1987*].
21. 'Fordism' in this article refers to a practice of work organisation found typically in semi-automated mass production. This is to be distinguished from a wider concept of Fordism as a regime of accumulation. For a useful discussion of the crisis in Fordism, in the latter sense, see Roobeek [*1987*].
22. The Babbage principle says that labour power capable of carrying out a range of jobs may be trained more quickly and bought more cheaply as dissociated elements than as capacity integrated in a single worker. See Babbage [*1832*].
23. For further discussion, based on the Italian car industry, see Le Ven and Neves [*1985*].
24. The data collected from the firms' personnel departments suggests extremely low rates of turnover for 1984: 0.5 per cent in the case of Firm A and 0.1 per cent in the case of Firm B. These figures are based on a series of 12 months (unlike those for 1984 in Table 9), but are not strictly comparable with the Ministry of Labour data of Table 9.
25. This is not to deny the possibility of setbacks. For example, in 1986 the hardliners came out strongly in an industrial dispute in Firm B. The deterioration of the relationship between the workers' council and management, following a strike, resulted in the dismissal of all representatives of the council. However, as John Humphrey pointed out to us, it is hard to predict whether this is just a temporary setback. Smashing the metal workers' own organisation could be a step towards the creation of company unions.
26. For a discussion of quality circles and their relevance in Brazil, see Salerno [*1985*].
27. For details, see Schmitz [*1985a*] or [*1985b*] for a summary, and Carvalho [*1987: Ch.2*] for a comprehensive survey on technology and labour use in Brazil.
28. For this discussion of the workers' responses to automation we owe special thanks to Nair Bicalho de Sousa who was in charge of this part of our joint research project.
29. For a detailed discussion see Roque A. Silva [*1985*].
30. The legal norm was 48 hours at the time of fieldwork, but the practice was less. How much less depended on the agreement between unions and employers' federations. There were also variations between enterprises because some workers' councils had been able to achieve further reductions. The new Constitution of 1988 reduced the legal norm to 44 hours.
31. According to research by Elizabeth B. Silva [*1988*].
32. The growth of jobs and skills in the Brazilian electronics industry has been documented and analysed by Hewitt [*1988*].

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