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Technology Development: The Diffusion of Micro-electronic Industrial Machinery in Malaysia

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INTRODUCTION

The era of the late 1970s and early 1980s witnessed significant advances in the use of micro-electronic (ME) industrial machinery. Further, with increasing research on artificial intelligence, there now exist micro-processors that can perform some functions of human being, such as flexible manufacturing for small size jobs. As result of these industrial advancement, processes such as electronic component assembly and garment manufacturing which had been the traditional hallmarks of labor-intensive operations have now become highly capital and skilled labor-intensive with equipments (such as robots) gradually replacing labor. Consequently, many multinational corporations (MNCs) now find it much harder to justify using offshore plants located in low wage countries for the supply of intermediate inputs. This, together with stagnant market conditions have led to significant cutbacks in the scale of operations of many multinational electronic and textile plants in Third World countries including those in the Association of South East Asian Nations (ASEAN). Malaysia, in particular, has experienced the closing down of many electronic plants since 1985, leading to retrenchment of thousands of electronic workers. In this situation advancements and changes in industrial equipment, especially those involving the substitution of ME machinery for labor, therefore have profound impact on the Malaysian economy.

The introduction of micro-processors and automation in Malaysia is governed by many motivations. The rising industrial wage rates since the late 1970s have led many factories in introduce Computer Aided Design (CAD) and Computer Aided Machinery (CAM) systems of robots in place of human assembly lines to maintain their competitiveness. Further, the need among the small engineering workshops to produce

components up to the specifications of the large primary firms requires the use of numerically-controlled (NC) machines and CAD/CAM systems for their production process.

The employment and income implications of the ME industrial machinery still are not clear. Although there were massive retrenchments in 1985 as a result of the global recession and the relocation of assembly lines back to the multinational parent companies and to other developing countries, several electronic companies had announced plans to upgrade and automatize their operations in Malaysia by 1987. This included plans by National Semiconductor and INTEL to build wafer fabrication plants using robots and NC-machinery.

Does this mean that diffusion of ME machinery could lead to substitution of equipment for labor? Does it also mean that the economic spinoffs of such technologies would lead to increased demand for labor, particularly skilled labor thus leading to substantial improvement of income levels? In analyzing the factors causing multinationals to either pull back their operations from Malaysia to their home countries or upgrade the level of technology in their subsidiary plants, one has to distinguish between the effects of the global recession and the impact of increasing availability of ME technology. The global recession with its consequent reduction in demand for products would lead to a net reduction in production capacity, however, the wide availability of ME technology would lead to replacement of non-automated by more automated production processes. The effects of these different factors could be analyzed only through empirical discussions with the multinationals concerned. It is the purpose of this study to answer these issues within the context of Malaysia.

For the rapid progress of the country to be sustained, there will have to be more rapid upgrading of its industrial technologies. It has been shown that if the industrial wage rate was to increase by 50 percent from the level in the early 1980s, the vast majority of the electronic assembly plants would lose their comparative advantage in the sense that the domestic resource cost coefficient would exceed unity.[1]

If Malaysia wishes to compete in the world market for the export of manufactured goods, it is crucial that it assimilates the latest manufacturing technologies particularly those related to ME process. Fortunately, this as pointed out previously, has already been done in particular by multinationals located in the country. Not withstanding the importance of ME technology to Malaysia's economic development.

the country still has not formulated a coherent policy to coordinate systematically the rapid introduction of ME equipment in the workplace and to optimize their economic impact with respect to labor productivity and employment. This paper seeks to provide a perspective on the employment and income implications of the application of the ME industrial machinery, especially the role of ME technologies in improving labor productivity and international competitiveness in various industries.

More specifically, the objectives of this paper are:

1. to examine the extent to which ME industrial machinery has been applied by the various industries, in particular in the electrical and electronic, automobile, and engineering equipment manufacturing industries,
2. to examine the impact of ME industrial machinery on employment, labor productivity and competitiveness of the firms, and
3. consider policy measures to encourage the diffusion of ME machinery.

Primarily the paper is based on a modest scale company survey in Singapore and Malaysia. The scale industrial composition of the sample is given in Table 1. The total sample consisted of 28 firms in Malaysia and 16 in Singapore.

TABLE 1. Sample composition

Industry	Country	Number of firms
General machine	Malaysia	13
	Singapore	6
Electrical and electronic machinery	Malaysia	9
	Singapore	7
Automobile and auto-components	Malaysia	4
	Singapore	0
Computer and computer components	Malaysia	2
	Singapore	3
Total		44

Source: Own Survey

AN OVERVIEW OF THE MICRO-ELECTRONICS DIFFUSION IN MALAYSIA

Data on the diffusion of micro-electronic machinery in Malaysia are scarce, however, the two studies by Sieh-Lee Mei Ling and Susan Tho[2], one in 1986 and the other in 1987, provide a rough idea. The 1986 survey covered 127 firms from various industries and the 1987 study covered 120 firms. Their main objectives was to examine the strategies adopted by the manufacturing companies to improve their performance. They also examined the extent of diffusion of ME machinery in different industries and the prospects and potential of such machinery in Malaysia. For each study well over a thousand questionnaire forms were sent out, but only 120-130 responses were received. Apart from this low response rate, there was also a possible bias in response since the better performing firms would be more inclined to respond to a questionnaire of this nature.

The conclusion of the 1986 study was rather pessimistic in the sense that, "well over 70 percent of the respondents do not think that CAD/CAM, automatic material handling and robotics are at all applicable." In 1987, however, Sieh-Tho found some indications of the beginning of diffusion of ME equipment. Compared with findings a year ago, the present survey shows definite increase in recognition of applicability of automatic material handing and robotics. Amongst respondents with actual experience of high technology options, the level of utilization had risen for CAD/CAM, automatic material handing and robotics." (Sieh-Lee Mei Ling and Susan Tho Lai Mooi 1987).

The major users of CAD/CAM systems were the electrical and electronic machinery, the transport equipment and general machinery industries. About 32 percent of the companies in the electrical and electronic machinery industry indicated some use of CAD/CAM systems with about 24 percent of them already in the initial to moderate stage application. In the transportation and general machinery industries, 24 percent of the respondents indicated some use of CAD/CAM systems but they were still in the initial stage of ME application. For the other industries, over 80 percent of the firms did not use any CAD/CAM system. However, it must be pointed out that some firms in rubber and oil palm processing, wood and paper and textile manufacturing reported between heavy to full usage of CAD/CAM systems. With respects to robots, again the major users were in the electrical and electronics subsectors (over 58 percent of total usage) and transport

equipment machinery and engineering (23 percent). Usage of robotics in the other subsectors however, is fairly sparse.

Regarding the future, about 42 percent of the firms in rubber and oil palm processing intended to give moderate to significant usage of CAD/CAM system as compared with, 16 percent to 30 percent in food and beverages, wood and printing, chemicals, metallic products, non-metallic products and textiles subsectors. More significantly, about 40 percent of the electrical and electronic firms reported that they would give increasing emphasis to the usage of CAD/CAM systems in the next two to three years. With respect to robots, the major prospect for increased usage was found only in the electrical and electronic subsector. Over 75 percent of the firms in this sector reported that they would give at least moderate to significant emphasis for the usage of robots in the future. In the other subsectors majority of the firms reported that robots were not applicable or they did not feel it necessary to introduce them.

COMPUTERIZATION

Malaysia's level of computerization can be classified as being the fourth largest user of computers in Asia, in terms of expenditure on electronics data processing (EDP) equipment as a percentage of Gross National Product (GNP). Malaysia's expenditure on EDP equipment as proportion of GNP amounted to 0.6 percent in 1986 compared to 1.8 percent for Japan, 1.3 percent for Singapore and 0.7 percent for Taiwan. United States of America, the world's most intensive user of EDP equipment, spent about 2.5 percent of its GNP on EDP equipment.

In Malaysia, EDP's equipment is found predominantly in the private sector. The number of total mainframe and minicomputer installations have increased from 625 units in 1982 to 916 units in 1986. Of these, over two-thirds were installed in the private sector. The Malaysian Association for Computer Industries has estimated the current size of the Malaysian market for computer hardware to be about $500 million ringgit per annum; with over 550 companies being involved in the manufacturing, import and export, and retailing of computer.[3] As a whole, the computer industry has been projected to grow at the rate of about 10 percent per annum.

A major thrust of Malaysia's computerization effort is emphasis on domestic manufacture of computer hardware. The Malaysian Industrial Development Authority has issued over 15 licenses for the

manufacture of computers and peripherals. However, given the increasing competition in the world market, there are currently only three companies manufacturing personal computers – Accent Technology, Complex Computers and Microcomputer Systems. The production capacity of these 3 local manufacturers is about 500 units of International Business Machine (IBM) compatible personal computers (PCs) per month. Based on the domestic demand of about 2,000 unit per month this implies a continued dependence on imports even for the relatively low technology PC market.

With respect to the diffusion of computers by sectors, Wong Poh Kam (1988) found that there was a total of 1,527 large and minicomputers installed at the end of 1987 with a current value of about $520 million ringgit.[4] The bulk of these installations were used in finance (24 percent), business services (17 percent), government (14 percent) and manufacturing (13 percent). The balance were used predominantly in wholesale and retail business. The government sector, particularly the universities and research institutions, accounted for nearly a half (44 percent) of the large installations (see Table 2).

TABLE 2. Malaysia: Computer usage by sectors, 1987

Computer size	No. of systems	Govt.	Finance	Business services	Mfg.	Wholesale/ Retail	Others
Large	32	44%	———	———	56%	———	———
Medium	493	24%	———	———	76%	———	———
Small	1,002	8%	27%	19%	11%	13%	22%
Total	1,527	14%	24%	17%	13%	——— 32% ———	

Source : Wong Poh Kam, 1988

Notes : Figures include multi-user computer systems and exclude PCs
Large : > 128 users
Medium : 17 - 127 users
Small : 2 - 16 users

Computer usage varies by the size of the firm. The Sieh and Tho (1987) study indicates this point clearly. As shown in Table 3, in all business activities, the large firms reported "heavy" or "full" usage of computers, for example, in operations for production scheduling, 34.5 percent of the very large firms reported heavy usage of computers compared to only 5.3 percent for the small firms. Similarly, in sales and marketing 56 percent of the very large firms reported heavy usage of computers for order entry compared to only 9.1 percent for the small firms. Table 3 suggests firstly, that there is a relatively extensive diffusion of computers among the large firms and secondly, even among the small firms, a significant proportion of them have begun to use computers in their everyday work indicating the beginning of a diffusion process in computer usage in everyday industrial life in Malaysia.

The data discussed in this subsection indicates the increasing use of ME machinery, particularly CAD/CAM systems and robotics. Such systems are now widely used in the electrical and electronic and the machinery industries. Prospects for the diffusion of CAD/CAM systems to other industries appear to be emerging with many firms in the manufacturing sector reporting to giving some emphasis to CAD/CAM systems in the future. Prospects for increasing the use of robots however, appear to be bright only in the electrical and electronic machinery industry and less encouraging in the other industries.

EDP is also beginning to be important in Malaysia, specifically in the service and the manufacturing sector. In the service sector, computerization is found to be most extensive in finance, administration, sales and marketing. In the manufacturing sector, usage of computers is prevalent among all subsectors, particularly the electrical and electronics, as well as the transport equipment machinery and engineering and general machinery industries.

TRADING PATTERN OF ELECTRONIC DATA PROCESSING EQUIPMENT

Since the use of ME equipment is closely related to the extent of usage of EDP equipment, there is a need to analyse the quantum of imports of EDP for ASEAN countries. Among ASEAN countries Singapore is by far the largest importer of EDP equipment. Its total value stood at US$189 million in 1983 and US$391 million in 1986. Malaysia's direct imports of EDP equipment increased from US$32 million in 1982 to US$75

TABLE 3. Malaysia: computer usage by firm size, 1987

	% of respondents "heavy" to "full" usage*			
	Small ≤50	Medium 51 - 200	Large 201 - 500	Very Large >500
Finance & administration				
Cost accounting	19.0	24.3	35.3	62.5
Not applicable	25.0	5.7	5.6	0
Financial performance reporting	19.1	48.6	41.2	80.6
Not applicable	27.6	0	5.6	3.1
Budgeting	20.0	22.8	41.2	54.9
Not applicable	28.6	0	5.6	3.1
Sales & marketing				
Order entry	9.1	28.1	29.4	56.0
Not applicable	21.4	8.6	5.6	19.4
Sales planning & analysis	20.0	20.0	17.6	32.0
Not applicable	25.9	14.3	5.6	19.4
Sales Forecasting	20.0	17.2	17.6	33.4
Not applicable	25.9	14.7	5.6	22.6
Operations				
Master production scheduling	5.3	10.3	17.6	34.5
Not applicable	34.5	12.1	5.6	6.5
Materials requirement planning	15.0	0	18.8	36.6
Not applicable	31.0	3.1	5.9	3.2
Iventory status	11.2	33.4	37.6	54.9
Not applicable	37.9	2.9	11.1	0

Source: Sieh-Lee Mei Ling and Susan Tho Lai Mooi, 1987, op. cit.

Note: *Based on a sample of 120 firms with ranking as follows:
1 - manual, 2 - initial stage, 3 - moderate use, 4 - heavy use, 5 - fully use.

million in 1984. However, this undertestimates Malaysia's imports of EDP. Traditionally a significant proportion of Malaysia's imports is effected by traders in Singapore who unpack imports in Singapore before shipping them across the Causeway to Malaysia. Thailand came in third with an import value of US$10 million in 1982 and US$60 million in 1985. Indonesia's imports were higher than Thailand's in the early 1980s, but were considerably lower in 1985, amounting to US$54 million. In the Philippines, EDP imports declined from US$28 million in 1983 to US$17 million in 1985 because of the shortage of foreign exchange and a generally unstable economic environment. Among the five ASEAN countries, Singapore is the only significant exporter of EDP equipment.

RESULTS OF THE FIRM-LEVEL CASE STUDY

This section, covers a discussion of the findings which emerged from the firm-level interviews successfully conducted in Malaysia.

SAMPLE

The membership list of the Federation of Malaysian Manufactures was used as the basis for selecting the sample firms. Telephone calls were made to ascertain whether the selected firms had adopted any type of ME machinery relevant to the study. About 100 firms which gave a positive reply were selected for interviewing. Difficully in securing cooperation for the study and logistic problems reduced the final size of sample to only 44 firms. Of these 44 firms, 16 are in Singapore and the remaining in Malaysia. The Malaysian based firms are distributed in the industrial zones of Kuala Lumpur, Shah Alam, and Penang. This distribution enables one to have a fair representation in terms of location. The profiles of the sample firms are summarized in Table 4. To hide the identity of the firms, a coding system is used; the firms which begin with "M" are based in Malaysia while those which begin with "S" are based in Singapore. The attached capital letters denote firms with 100 percent foreign ownership and small letters denote joint ventures while numerical firms are 100 percent locally owned.

In terms of the pattern of ownership, 50 percent were locally owned while 29.5 percent were foreign-owned. The remaining were joint-ventures. Most of the locally-owned firms were concentrated in general machine and component manufacturing, while the bulk of the foreign-

TABLE 4. The number of ME machines used by the sample firms and their labour saving effects.

Sample firms	No. of employes	Duration of Me adoption (years)	Machines intalled	No. of workers save
General machine				
M1	65	7	6 lathes	12
M2	25	4	2 milling 1 wire cuting 2 grinding	8
M3	90	8	-	
M4	20	5	-	
M5	132	1	-	
M6	15	16	-	
M7	17	1	-	
M8	1	5	1 lathes 1 milling 1 shaping	15
Ma	15	9	2 wire cutting 2 EDM 1 MC	8
M9	30	5	-	
M10	70	9	1 lathes 1 milling 1 wire cutting 3 EDM	21
M11	14	1	1 EDM	0
M12	30	4	2 lathes	20
SA	40	4	-	
Sa	12	3	26 lathes 1 milling 1 hole drilling	
S1	25	5	-	
SB	350	13	-	
S2	35	2	6 lathes	24
S3	300	4	-	
Electrical and electronic machinery				
MA		4		
MB	922	3		
M13	800	1		
MC	1276	6		

(continued to next page)

TABLE 4. *(continued)*

		1	1 jesting robot 3 assembly robots	7
Mb	68	6	5 CAD/CAM systems	0
ME	182	2	3 CAD/CAM systems	9
MF	735	6		
Mc	1250	10	9 lathes 4 milling 6 wire cutting 4 MC 18 painting robots 23 assembly robots	363
SC	1500	4		
SD	700	4		
Sb		3	4 material handling robots 5 coating robots	9
SE	202	4		
SF	3000	6		
Sc	4	6	1 wire cutting 1 drilling 2 sawing/ cutting	24
SG	20	6		
Automobile and auto components				
M14	13	7	1 lathes 1 MC	7
Md	1337	4		
Me	337	1		
M15	22	2	9 lathes 2 MC	58
Computers and computer components				
M16	36	1	2 lathes	18
M17	10	1		
S3		1		
S4		6	1 CAD/CAM system	100
Sd				

owned firms were in the electrical and electronic machinery industry. The locally-owned firms were generally small in terms of employment, foreign-owned firms were generally large including world renowned companies from the United States, Japan and Europe.

Table 5 shows that the use of NC-machines and CAD/CAM systems was spread out among the three regions in Malaysia. The table shows that most firms began to use ME machinery in the late 1970s to early 1980s, when ME equipment became relatively cheap and popular especially in some manufacturing processes requiring design and sequencing. The experience of M3 which is a locally owned firm based in Penang, is indicative of this conclusion. In the mid-1970s, the firm began to feel the need to adopt NC-machines as it was unable to cope with the increasing demand for the machine components (for example plates, shafts and cranks) for the repair and maintenance market. There were also increasing complaints from its customers who found its products inconsistent in quality, leading to high rejection rates. It evaluated the cost-benefits of introducing NC-machines in the late 1970s, but found the machines to be too expensive, particularly the programmable NC-machines, because of the high costs for the computer that came with the systems. By 1980, however, ME machinery had become widely available and cheap. The price of NC-machines declined by 50 percent in ringgit terms between 1975 and 1980. The company then found it economical to introduce NC-machinery. Its experience with the NC-machine was so positive that in 1984 the company also installed a CAD/CAM unit for in-house design of machine parts and components. Similar experience was echoed by other companies such as M10, Mb and M14.

Table 6 shows the diffusion of ME equipment by firm size. Of the 38 firms that provided data on the number of workers, 47.4 percent had fewer than 50 production workers, 15.8 percent between 50-199, and the remaining 36.8 percent 200 or more. The sample also includes one firm with production workers in excess of 2,000 which is a European multinational producer of consumer electronic items.

While NC-machinery and CAD/CAM systems were used by both large and small firms, robots were used mainly by the larger firms particularly those with 200 or more production workers. NC-machinery and CAD/CAM systems are ME equipments specially applicable to small lot and flexible manufacturing processes, and their prevalence amongst firms of all sizes is therefore not surprising. On the other hand, robots are expensive equipment which requires large lot sizes for their comparative

TABLE 5. Overall characteristis of the sample firms

	No. of firms which responded	Number of firms with		
		NC-machine	Robot	CAD/CAM
Location				
Selangor (Malaysia)	14 (31.8%)	11	3	4
Kuala Lumpur (Malaysia)	9 (20.4%)	6	1	4
Penang (Malaysia)	5 (11.4%)	2	0	4
Singapore	16 (36.4%)	9	8	4
Total	44 (100%)	28 (63.6%)	12 (27.3%)	16 (36.4%)
Duration of ME use				
Less than 5 years	24 (55.8%)	13	7	9
5 - 9 years	16 (37.2%)	12	4	7
10 - 14 years	2 (4.7%)	2	1	0
15 years or more	1 (2.3%)	1	0	0
Total	43 (100%)	28(65.1%)	12(27.9%)	16 (37.2%)
Pattern of Ownership				
Wholly local owned	22 (50.0%)	19	2	7
Joint-venture	9 (20.5%)	3	7	3
Wholly foreign owned	13 (29.5%)	6	3	2
Total	44 (100%)	28 (63.6%)	12 (27.3%)	12 (27.2%)

Source: Own survey

Note : Firms may use more than one type of micro-electronic equipment. Hence the total may exceed the sample size.

advantage therefore their predominance in the large firms is to be expected.

It is, however, significant that almost one-quarter of the sample firms using NC-machinery had fewer than 20 production workers (Table 6). These firms are mainly locally-owned or joint-ventures. This suggests the emergence of high-technology small firms which are based on domestic entrepreneurship. Most of the firms are of recent origin and were established by entrepreneurs who had been exposed to micro-electronics through formal education in their work enviroment, for example company M17, M7, M11 and M14.

TABLE 6. The use of ME machinery by firm size

Firms size (no. of workers)	No.of firms which responded	Number of firms with		
		NC-machines	Robots	CAD/CAM
Less than 20	9	8	0	2
20-49	9	9	1	2
50-99	4	4	0	3
100-199	2	1	0	1
200-499	5	2	2	1
500-999	4	1	2	3
1000-1999	4	3	3	2
2000 and above	1	1	1	1
Total	38	29	9	14

Sources : Own survey

Notes : 6 firms did not give figures on the size of their workforce.

ORIGINS OF TECHNOLOGY

The major issue concerning the adoption of ME equipments is the dependence of Third World countries on advanced countries for their technology supply. In the case of Malaysia and Singapore, this has been confirmed by this survey, which found that of the 43 companies that reported the origin of technology, 39 firms (90.7 percent) imported their ME equipment, mainly from Japan or United States. Four firms (two in Malaysia) purchased their ME equipment from secondhand sources within the country, while only one firm developed its ME equipment in-house. Most ME equipment were purchased directly from equipment suppliers. Large ME equipment suppliers have their own offices in Malaysia, while specialized (but relatively small) equipment

suppliers work through repsesentive offices.

While most of the ME equipment were imported, the presence of a small network for the supply of secondhand ME equipment is interesting. Three of the four firms which purchased their ME equipment from secondhand sources were foreign-owned firms while one is a joint-venture. They cited lower costs and familiarity with the second-hand sources as their major reason for the purchase of secondhand ME equipment.

With respect to sources of information or ME technology, a great majority of the local firms depended equipment suppliers and trade exhibitions. Twenty eight of the sample firms (65 percent) listed exhibition as one of their main sources of information. However, among 22 of the joint-venture and wholly foreign-owned firms, 16 (72.7 percent) reported their parent companies as the major source of information.

PURPOSE OF ADOPTING ME MACHINERY

Despite the much talked about labor-saving nature of ME equipment, reducing labor requirements was by no means a major purpose of its applications. Of the 25 Malaysian firms which responded to the question, 15 reported that their major objective was to improve the quality of products while another 12 wanted to cope with the increase in demand. Only 5 firms reported ME-machinery helped increase the productivity the firm or reduced the operating cost (See Table 7). Only 3 firms adopted ME equipment to reduce direct labor.

Among the general machinery manufacturing and the electrical and electronics industries in particular, producers of parts and components need NC-machines and CAD/CAM systems since most of their products are used for assembly by multinationals. The automobile assembly and component menufacturing firms cited improving the quality of the products and catering to increased demand as two major objectives of bringing in ME machinery. In these firms, the adoption of ME machinery like automated assembly, spot-welding robots, painting robots and automated machining have improved quality control, and increased the possibility of working to severer tolerances.

This findings suggest that the strong presence of multinationals has been the main impetus for domestic enterprises adopting ME equipment. These multinationals (particularly among the electrical and electronics industry in Malaysia, and the electrical and electronics and

TABLE 7. Purpose of adopting ME machinery

Firms	Increase productivity/ reduce cost	Increase demand	Improve quality	Increase output	Reduce Labour	Import substitution	No. of firms responded
Malaysia							
General machine manufacturing	2	5	6	3	3	3	12
Electrical and electronics	3	4	5	5	0	0	8
Automobile assembly and component	0	2	2	0	0	1	3
Computer & computer component manufacturing	0	1	2	0	0	0	2
Sub-total	5	12	15	8	3	4	25
Singapore							
General machine manufacturing	0	3	2	0	0	0	3
Electrical and electronics	2	4	5	3	0	0	7
Computer & computer component manufacturing	1	1	1	1	0	0	2
Sub-total	3	8	8	4	0	0	12
Total (100%)	8(21.6%)	20(54.1%)	23(62.2%)	12(32.4%)	3(8.1%)	4(10.8%)	37

Sources : Own survey.

the general machine industries in Singapore) have encouraged many ancillary firms to adopt NC-machines, CAD/CAM systems or even robots.

In brief, the adoption of ME machinery is mainly aimed at higher and more regular qualities of work and greater flexibility of the manufacturing systems to respond quickly to the increases in demand and economically produce small lots.

EFFECTS ON LABOUR

As shown in Table 8, only 7 (5 in Malaysia and 2 in Singapore), or 23.3 percent of the 30 firms providing data on the change in the workforce before and after ME adoption, reduced the number of production workers after the adoption of ME equipment, while 12 firms (40 percent) reported an increase in the workforce. The remaining 11 firms reported no change in the workforce size, reassigning the production workers saved by the substitution of ME equipment for non-ME equipment to other parts of the firm. This was possible, because most of these firms are fairly large.

Seven firms reported a reduction in the workforce. The seven cases taken together, shows a reduction in the number of production workers from 1303 to 883. Most of the firms however, agreed that the reduction in the workforce could not be attributed to the adoption of technology alone. Some of this could be due to factors such as the decrease in demand due to the global recession and increasing competition. Firm Mb is an example. The firm reported that no worker had been saved with the adoption of 5 CAD/CAM systems. However, the firms workforce was reduced by 112, after the adoption of the technology. Futher interviews with the company revealed that the firm, a joint-venture involving a well-known European multinational manufacturer of electrical appliances such as hand-tools, was severely hit by the global economic slowdown in the mid 1980s. It lost a substantial part of its traditional export market and had to close down two of its traditional production lines which had resulted in the cutting down of its workforce by 112. Fortunately, its CAD/CAM technology, introduced in 1982, enabled it to venture into the manufacture of new products which were in greater demand. By 1988, Business had begun to pick up due to the flexibility accorded by the CAD/CAM technology. The seven firms which reported a reduction in their workforce after the adoption of ME technology, also reported that the move was carried out over a long period of time. After providing surplus workers ample opportunities

TABLE 8. Effect of ME technology on the workforce size

Firms	Contraction in workforce	Increase in workforce	No change	Number of firms responding
Malaysia				
General machine manufacturing	4	5	4	13
Electrical and electronics	1	1	4	6
Automobile assembly and component manufacturing	0	1	1	2
Computer and computer component manufacturing	0	1	0	1
Singapore				
General machine manufacturing	0	3	1	4
Electrical and electronics	2	1	1	4
Computer and computer component manufacturing	Na	Na	Na	0

Source : Own survey.

Note : Figures do not add up to the number of firms surveyed because not all responded to the question. Na denotes not available.

for retraining this enables them to take on new jobs within and outside the company.

Although the study found that the extent of labor displacement is not significant it would be interesting to examine the extent of potential employment that might have been needed if ME machinery had not been introduced. As indicated previously, most firms felt the adoption of ME technology had helped increase their output by increased flexibility and shortening of production time, but it had not saved much labor. Many firms could not indicate the exact number of workers saved per machine adopted. This was because the machines were used for different purposes, and under different conditions, which made "quantifying" the labor savings an almost impossible task. Nevertheless 19 firms provided same data, which are summarized in Table 4.

Table 4 shows that although labor was saved at 13 out of the 14 firms through integrating a number of processes of complex machining works into a single line, the actual number of workers employed continued to increase at 6 of the firms due to the growth of output. At Company M14, for example, the adoption of two NC-machines resulted in a saving of 7 positions, but the "surplus" workers were transferred to other positions. Further, as a result of the increase in production four new skilled jobs were created, that is three NC-machine operators and one trainer of NC-machine operators.

Only two firms reported on the labor-saving effects of robots. Firm Mc, which recorded the largest labor savings (320), actually increased its production workforce by 25 percent after the adoption of robots. The firm, a joint-venture involving a well known and progressive Japanese multinational, had chosen Malaysia to be its exporting platform for television and video recorders. Since these consumer durables carried its brand name, high quality standards had to be maintained. For this purpose, the firm considered the use of robots in the new manufacturing operations essential. Thus, the saving of 320 workers as a result of the introduction of robots was a "theoretical estimate," since the company could not have started with a traditional production line to produce television and video recorders for the export market in the first place. The new markets generated by the new robotic production line had resulted in the need to recruit additional skilled and unskilled workers.

In brief, the adoption of NC-machines, robots and CAD/CAM systems had saved at least some labor, but the latter has been reabsorbed as a result of the growth of demand. In many cases these "savings" were "theoretical" since the companies introduced ME machines to cater to

new markets, and not to replace conventional production lines. In other words, the adoption of new technology may not cause a decline in employment, if economic growth can continue at a rapid rate.

Table 9 shows the type of training provided to workers upon the adoption of ME machinery. Among the 42 firms responding to the question, 47.6 percent of the firms received initial on-the-job training from the equipment suppliers. Such training was for key workers only. About 28.6 percent of the firms also sent their key workers abroad for training or brought in foreign experts to train their key workers. In 40.5 percent of the firms, these key workers later provided in-house training for other workers.

With respect to the attitudes of workers towards ME adoption, 10 percent of the firms reported that the workers had initially expressed uneasiness for fear of retrenchment or their inability to cope with the new environment. Not all workers affected have been happy about the change, especially the less "adventurous" older workers. However, in over 85 percent of the firms the workers were generally receptive of the adoption of ME equipment. Most of them, in fact looked forward to the new challenges and new opportunities. These firms felt that consultation was the key to the successful adoption of the new technology. Through discussions with their workers, that they felt they could avoid difficulties which might otherwise have occurred. Generally, the managers also felt that they should attempt to "market" their new technologies to the workforce to ensure their acceptance. Firms which reported no strong objections from their workers to the adoption of ME machinery usually introduced it slowly, mixing old and new production methods. Workers would then take the introduction of the new technology more as a learning process instead of a threat to them. Trade unions were aware of the positive effects of the new technologies. Their concern was that the welfare of the workers might be sacrified somehow in adopting the new equipment. Generally, they felt issues such as education, retrainning and the social impact should be looked into seriously before a decision to bring in new production methods was made. Generally, trade unionists would feel more comfortable if they participated in decision-making.

CHANGES IN WORK ORGANIZATION

Eighteen firms (46.2 percent) reported that ME adoption did result in some change in their work organization. Apart from the creation of

TABLE 9. Training for workers

Firms	In-house among peers	Overseas Training/ Foreign Experts	Formal Courses/ Seminar country	Provided by Suppliers within	No. of Firms Responded
Malaysia					
General machine manufacturing	2	4	-	8	13
Electrical and electronics	5	3	1	1	9
Automobile assembly and component manufacturing	-	-	-	2	4
Computer and computer component manufacturing	2	1	-	1	2
Singapore					
General machine manufacturing	3	2	-	3	6
Electrical and electronics	4	2	1	5	7
Computer and computer component manufacturing	1	-	-	-	3
	17(40.5%)	12(28.6%)	2(4.8%)	20(47.6%)	42(100%)

Source: Own survey.

new departments to accommodate the ME work-stations, air-conditioned rooms to accommadate the ME equipment, and rescheduling of handling raw materials, supplies and final products, it also induced changes in the workforce structure. At larger companies a new core of skilled personnel has been created. This "new group" would need to be integrated into the current workforce structure of the firm. As the rise of this skilled group could change the balance of power and control at all levels of the staff, the firms felt this could be a "potential" area of resistance by the present staff. Any defensive reactions to these changes could slow down the diffusion of the new equipment. For the smaller firms, changes in the workforce structure take the form of expansion in job responsibilities. For example, M8 found that, with the introduction of ME equipment they do not need the supervisory staff, and these staff were then retrained as skilled operators.

Twenty one (21) firms (53.8 percent) reported that ME adoption did not bring about any major change in the work organization. ME equipment was accommodated within the existing organizations, and existing operators were retrained to handle the ME equipment. These firms also did not experience any significant change in the labor structure. Sometimes, ME machinery has been introduced merely for the purposes of demonstration and for learning. In such cases it does not create much impact on the operation of the firms.

MARKET ORIENTATION

As indicated previously, an important motivation for adoption of ME equipment is quality improvement aimed at supplies of assembly parts to a major firm, or at meeting the specifications of the export market. Obviously the adoption of ME equipment would have an impact on the market orientation of the firm.

Acquisition or improvement of the ability to undertake subcontracted work for major companies, notably multinationals in the country is an important consequence of adoption of ME equipment by locally owned firms. Of the 22 locally-owned firms, 12 had increased such work, 10 of them having been able to switch from replacement parts production to a combination of replacement and original parts production work. Four out of 9 joint-venture firms, and 6 out of 13 foreign-owned firms reported an increase in the amount of subcontraced work as a result of the adoption of ME equipment (see Table 10). This is not surprising since many foreign-owned firms in Malaysia and Singapore

TABLE 10. Changes in the Sub-contracting on adoption of ME technology

	Completely final products	Completely sub-contracted work	Sub-Contract and final product	Completely final products to subcontracted work	Increase in pro-portion of subcontracted work	No. of firms responded
Locally owned firms	8	-	2	10	2	22
Joint-ventures	2	1	2	3	1	9
Foreign owned firms	1	2	4	2	4	13
Total	11(25.0%)	3(6.8%)	8(18.2%)	15(34.1%)	7(15.9%)	44(100%) .

Source : Own survey

serve as an offshore part and component production base for their parent companies. Adoption of ME equipment would be a strategy which these subsidiaries could use to increase the quantum of sub-contracted work from their parent companies. For smaller firms, ME machinery is often introduced for the production of.

As Table 11 shows, 12 firms reported changes in the market orientation of their products as a result adoption of ME equipment. Six of them used to cater only to the domestic market before the ME adoption but now supplied both the domestic and export markets. The other six firms increased their export ratios. Twenty-seven firms reported no change in their market-orientations of which 12 were completely export-oriented, 8 both domestic and export oriented and 7 completely domestic-oriented.

DETERMINANTS OF THE DIFFUSION OF ME MACHINERY

Since the major purposes of the firms adopting ME equipment are to improve the quality of work and to increase the production capacity to cope with new demands, it is natural that a majority (22) of the sample firms considered an improvement in the market conditions, particularly the increasing demand for high quality products and components, to be most the important factor encouraging the diffusion of ME equipment in their firms (Table 12). For 12 firms, the financial ability was the most important factor. Six firms mentioned the technological absorption capacity as the main factor encouraging the diffusion of ME technology. Most of the firms appeared to feel that supply-side constraints could be resolved if the market conditions were right for the adoption of ME technology.

Regarding major constrains on the diffusion of ME technology, 30 firms referred to the high costs of ME equipment as the factor. (See Table 13). This has been particularly true since 1986 when the dramatic appreciation of the Japanese yen began to inflate enormously the cost imported Japanese ME equipment. For example, M6, a machine manufacturer in Kuala Lumpur, purchased two NC-machines, at $100,000 ringgit each from Japan in 1984 but it had to pay $250,000 ringgit for a similar NC-machine in 1987. Poor technical assistance by the equipment supplier was mentioned for 14 firms, mostly locally-owned, which had to depend on the equipment supplier for assistance in installation, maintenance and operations.

TABLE 11. Changes in market orientation

Firms	No change			Change		
	Completely domestic market oriented	Completely export oriented	Domestic market and export oriented	Completely domestic to export/ domestic market	Increased % of exports	No. of responding firms
Malaysia						
General machine	5	1	2	4	1	13
Electrical and electronics	-	6	-	1	2	9
Automobile assembly and component	1	-	1	-	-	3
Computer and computer component	-	1	2	-	-	3
Singapore						
General machine	1	2	1	-	-	4
Electrical and electronics	-	2	2	-	1	5
Computer and computer component	-	-	-	1	1	2
Total	7(17.9%)	12(30.8%)	8(20.5%)	6(15.4%)	6(15.4%)	39(100%)

Source : Own survey

Note : Five firms did not respond to the questions

TABLE 12. Main factors encouraging the diffusion of ME technology

Firms	Market conditions (demand)	Technology absorption capability	Financial abilities	No. of responding firms
Malaysia				
General machinery	8	0	4	12
Electrical and electronics	5	1	3	9
Automobile assembly and components	0	0	3	3
Computer and computer components	0	1	1	2
Singapore				
General machinery	4	0	1	5
Electrical and electronics	2	4	0	6
Computer and computer components	3	0	0	3
Total	22(55.0%)	6(15.0%)	12(30.0%)	40(100%)

Source : Own survey

TABLE 13. Main factors inhibiting diffusion of ME technology

Factor	Singapore firms	Malaysian firms	Total	% of the sample firms (n=44)
High price of equipment	10	20	30	68.2
Low labour cost	1	2	3	6.8
High social cost	1	2	3	31.8
Poor technical asistance by supplier	4	10	14	13.8
Not enough work (Below optimal utilization)	1	5	6	13.6
Mismatch with respect to size	1	5	6	13.6
Mismatch with respect to quality	6	8	14	31.8

Source: Own survey

INCENTIVES AND ASSISTANCE

Table 14 shows that 28 companies had received assistance from their equipment suppliers, mainly as price discounts, installation of equipment and in-plant training of the operators. Equipment suppliers also provide long-term maintenance and upgrading services. Nineteen of the firms received financial incentives or assistance from the government to purchase ME equipments. There is still no specific incentives accorded for the installation of high-technological equipment, although any high-technological equipment (including ME machinery) purchased for research and development (R & D) purposes is entitled to a double deduction from the company's income declaration for tax purposes. This double-deduction benefit is what the six firms received.

In order to promote ME-related R & D, the government has taken a number of other measures. The Malaysian Institute of Microelectronic Systems (MIMOS) was established in 1985 to help in the research and development of micro-electronics design and its computer applications. The Coordinating Council for Technology Transfer was set up at the end of 1986 as part of the government's infrastructure support of industries to study, analyse and monitor programs on technology and microelectronics R & D. The Government has also set up a technology transfer center at the Standards and Industries Research Institute of Malaysia (SIRIM) to provide information, extension services and assistance in acquiring foreign technology, patent evaluation and training courses. Plans have also been drawn up for a National Center for CAD/CAM which will help train workers and provide facilities for the private sector enterprises. The Technology Park set up in July 1988 provides formal linkages between universities and research institutes on the one hand and the business community to coordinate ME-related R & D efforts on the other hand.

CONCLUSIONS

The use of robots is still limited in Malaysia, but the use of NC-machines and CAD/CAM systems has spread in the electrical and electronics, and the auto-component industries. Firms use them mainly to speed up production and to meet the quality standards set by the assemblers and by the export markets.

The major determinants of the pace of diffusion of ME technology is the rate of expansion of the world market for high technology

TABLE 14. Incentives and assistance

Firms	Goverment	Parent Company	Machine Supplier	Customers	No. of responding firm
Malaysia					
General machine	2	1	7	1	9
Electrical and electronics	4	6	5	2	8
Automobile assembly and components	0	2	3	0	3
Computer and computer components	0	1	1	0	2
Singapore					
General machine	5	1	4	0	5
Electrical and electronics	5	4	6	0	6
Computer and computer components	3	1	2	0	3
	19(52.8%)	16(44.4%)	28(77.8%)	3(8.3%)	36(100%)

Source: Own survey

Note : Most firms listed more than one incentive or from of assistance

products. The major constraint is the high cost of ME equipment, which has become particularly serious after the significant appreciation of the Japanese yen. In about 50 percent of the firms surveyed, the adoption of ME equipment did not lead to any significant change in the employment level since most of the displaced workers were reassigned to other posts in the establishments. In a small number of factories, the introduction of ME technology had in fact led to an expansion of the workforce, particularly with respect to skilled and managerial labor. In some establishments, however, it caused a significant displacement of labor, some as much as by 50 percent reduction in direct workforce. Most of the displacement fortunately took place over a period of several years, with the companies providing retraining opportunities to the "surplus" workers to help them look for other jobs.

The need for recruitment of unskilled workers decreased significantly, while the demand for skilled operators grew a little. In the majority of the firms, there was no massive retrenchment of the existing unskilled workers as the ME equipment was purchased to cater to new demand. Th findings of this study do suggest, however, the emergence of the "skill twist" effect among these firms. In the medium term, this could lead to a significant shift in the profile of the workforce in these firms.

The major sources of information on ME technology differ, depending on the ownership structure of the firms. Among the locally-owned firms, the most important are trade exhibitions and equipment suppliers. Among the foreign-owned and joint-venture firms, foreign parent firms or partners were the primary source. Installation of ME machinery was also accompanied by extensive training of local workers to enable them to operate the new technology.

If technology transfer is defined to include transfer of operating ability to workers and manegerial ability to the supervisors, the diffusion of ME technology in Malaysia had led to some technology transfer. However, all the needed equipment was imported. Electronics and electrical equipment producing firms generally spent an average of about 6 percent of their sales on R & D. In the automobile and auto-parts industry, it was less than 4 percent. The figure is also higher among the wholly foreign-owned firms (about 7 percent) and least among the joint-venture firms (less then 3 percent). There are somewhat low figures for expenditure domestic R & D. Adaptative and innovative efforts are still absent.

However, the ME technology has significant effects on the industrial

structure. ME technology is likely to improve the user's labor productivity, particularly among the small firms in the electronics and electrical machinery and the general machinery industries. Secondly, it will increase linkages between small and large firms in these industries through the promotion of subcontracting. In the long run, a further diffusion of ME equipment may enable Malaysia to attract a greater inflow of foreign investment and thereby to sustain its higher wage rates (compared to those in Thailand and Indonesia) within the context of better infrastructure supporting system.

For many export-dependent industrializing Third World nations, the diffusion of ME equipment represents a development dilemma. It is capital-intensive, and tends to save labor, particularly unskilled labor. However, the failure to adopt ME equipment will constrain the country's export of manufactured products to advanced countries, which increasingly requires such high quality and service standards that could be met only with ME equipment. This is a particularly important issue for all ASEAN countries which seek to accelerate industrialization through the promotion of export-oriented manufacturing activities.

The experience of Malaysia indicates that the diffusion of ME equipment, if promoted carefully, could bring about great benefits to the economy. At the macro level, this findings indicate that one need not be too fearful of its labor displacement effect. To ensure that the rate of diffusion of ME technology within an economy is consistent with its socio-cultural norms, the government should formulate a comprehensive policy including a National Information Technology (IT) Policy within which the role of ME technology is clearly specified.[5]

In particular, the ME industry should be regarded as a "strategic" industry that is an industry that can help achieve national goals and objectives. Specific policies should then be formulated to enhance the adoption of ME technology. These include, (1) provision of specific grants and financial assistance to encourage adoption of ME technology, (2) organisation of seminars and courses on ME technology, as well as provision of extension services and facilities for ME research and development activities, (3) assistance for management and labor retraining, and marketing of ME-related new products and services, and (4) motivation for programmers and technologies to produce software and hardware for the ME industry.

A key to success in ME application is the worker's acceptance. Although this study revealed minimal resistance, the diffusion of ME could be futher enhanced by minimizing labor displacement effects as

well as by improving the demand-side factors relating to the absorptive and adaptive capabilities in each economy. This is particularly important among labor-abundant countries such as Indonesia, Malaysia, Philippines and Thailand. For this purpose, the government could implement a series of short, medium and long-term measures.

In the short term the government should assist in retraining of existing to enable them to manage and supervise the new machinery. The government could provide fiscal incentives, such as double deduction for retraining expenses in the income declaration while equipment suppliers could be provided with similar fiscal incentives to assist the adopting firms by intensifying their training programs. In the medium term, it is necessary for the government to encourage the production of more computer and information science graduates from the local vocational training institutes and universities. At present, such training institutes are still lacking in Malaysia. There are only two official vocational training institutes in computer science and information technology. In the long term, there need to be a greater emphasis in the government's educational policy on science and mathematics, and in this respect training in computer and data processing needs to be introduced in schools. The first step in this direction has already been taken when the Ministry of Education announced that computer studies will be offered as an elective subject in secondary schools from 1990. However, to ensure that more students would avail themselves of this subject, there needs to be a significant increase in the supply of hardware and qualified teachers.

Even with the best retraining programs, labor displacement cannot be avoided if total output does not expand sufficiently to compensate labor productivity gains. To enhance output, the government should work closely with the firms to improve the quality of their products and to promote exports. The current set of export incentives has not been extensively utilized by Malaysian firms, partly because they are not considered attractive enough to warrant the trouble an industrialist incurs in applying for one. More attractive incentives, including a greater export allowance and an increased subsidy regarding personal expenses incurred in exporting, may be offered.

The importance of R & D has to be stressed. The technology absorption capacity of the domestic economy can be improved through enhancing the domestic R & D, which could also rectify the over-dependence on advanced economies for the supply of ME technologies. Beside encouraging the involvement of local expertise in R & D, the

government could consider the possibility of setting up national science institutes to undertake fundamental technology research. These research institutes could be modeled along the line of the Korean Institute of Advanced Science and Technology (KIAST) which has been instrumental in upgrading Korean technology over the past decade. However, one must be aware of the danger of being carried away too far. Developing countries often see the building of institutions for basic research as a first step in the innovative chain. For these institutes to be effective, there must be links between these institutions and the industry. The output of these institutions must reach the target groups before their work has any substantial effects. This is clearly illustrated by the experience of KIAST which has close interaction with the strategic industries in Korea such as electronics and information. Countries should therefore specialize in areas which they intend to develop and promote basic research in these areas in close consultation with the private sector.

It is well recognized that most Third World nations cannot afford to be the pioneer in all areas of ME industrial research. Most of the high technology innovations are bound to originate from advanced countries and transferred by multinationals. Since multinationals are profit-maximizing organizations. For a country to remain attractive to them, generous incentive such as tax-free holidays and investment-tax credits often need to be offered by the government. However, a greater emphasis must also be given to ensure the more intensive transfer of ME technology from multinationals to the localcompanies. A selective policy could be introduced in which imports of technology which is likely to generate domestic learning and innovation and complimentary with local efforts could be encouraged.

Investors are motivated by the quantum of profits that they can earn from an industrial project. Company-level incentives should therefore, ensure that establishments which modernize their equipment are financially rewarded, at least in the medium term. In this respect, the tax-holiday incentive should be redefined to include those firms which seek to replace their equipment with more modern ME technology. This incentive would be particularly applicable to the older engineering and component manufacturing establishments, such as the traditional engineering workshops, as well as the older iron and steel mills.

Notwithstanding the importance of universities and research institutes in ME related R & D, a large proportion of technological

innovations accrue from firms especially in the United States, Japan and Western Europe. To promote similar local ME related R & D, tax incentives may be offered with respect to ME related R & D expenses incurred by the firms concerned. Currently, in many developing countries including Malaysia, R & D expenditures are given double deduction for the purpose of income tax. However, before these expenditures are incurred, prior approval from the relevant Ministry of Finance has to be obtained. Due to the risky and uncertain nature of ME related R & D investments, it is quite impossible for firms to seek strict prior approval for ME related R & D expenditures and to have to stick to these expenditures for tax deduction. Hence, one finds that in Malaysia up to 1987, very few firms have applied for incentives for R & D expenditures.

For domestic R & D to be effective, it is also important that the government accords the private-sector assistance through provision of extension services and grants. Over the 1986-90 period, $400 million ringgit was allocated to only public-sector R & D institutes. Since the aim of the fund is to improve the competitiveness of Malaysian industries, and it is private-sector bodies that understand the problems of competitiveness best, it is essential that private establishments, including industrial firms be involved in identifying, formulating and implementing the R & D projects.

Another feasible promotion scheme would be for the government to establish a special fund for ME related R & D, which may be financed through a cess tax on the quantum of ME-based products exported.[6] From this fund, grants could be provided to industrial establishments to purse ME related and RD vital to the needs of the sector, and to support private ME related R & D institutes it aimed at upgrading the quality of the country's industrial output and the level of its ME technology.

Similarly, in order to promote a more rapid ME technology transfer, tax incentives also should be given to firms which undertake technology transfer in manners other then through the more restrictive multinational subsidiaries or joint-ventures. For example, tax relief could be offered against the licensing and royalty payments, expenditure incurred in sending staff abroad for direct technology acquisition, and expenditure incurred in training staff in the operation of the new equipment purchased directly. In the long run, this would lead to greater adoption and diffusion of high technology innovations.

NOTES

[1] Fong Chan Onn, *Technological Leap: Malaysian Industry in Transition*. Oxford University Press, Kuala Lumpur, 1986, pp.66. The domestic resource cost coefficient exceeding unity implies that the country would use more than 1 unit value of domestic resource (valued at shadow prices) to manufacture of product which would earn for the nation 1 unit value of foreign exchange.

[2] Sieh-Lee Mei Ling and Susan Tho Lai Mooi, *1986 & 1987 Malaysia Manufacturing Futures Survey, Vol. 1 and 2*. Faculty of Economics and Administration, University of Malaya, Kuala Lumpur, various years.

[3] M$ denotes Malaysian Ringgit. Since the early 1980s, the exchange rate for M$ has fluctuated considerably; in 1982 it was at its peak of M$2.20 to US$1.00, since then it has declined to M$2.50 to US$1.00 by 1985 and M$2.70 to US$1.00 by 1988.

[4] Wong Poh Kam, "I.T. Development in Malaysia: Status and Issues," SERES Sdn. Bhd., Kuala Lumpur, 1988.

[5] The interviewers spent a great deal of time trying to persuade many of the firms to respond to the questionaire. Many of the companies, in particular the MNCs, were reluctant to participate because of their need to maintain "secrecy."

[6] Jacobsson, S., "Technical Change and Industrial Policy: The Case of Computer Numerically Controlled Lathes in Argentina, Korea and Taiwan," *World Development*, Vol. 13, pp. 353-370, 1985.

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