
Microelectronics and the Garment Industry: not yet a perfect fit

Kurt Hoffman and Howard Rush

Current North-South trade relationships and the underlying structural characteristics which determine the resultant international distribution of benefits set the context into which microelectronics based innovations (MRIs) will be introduced. Any speculation on possible scenarios regarding the impact of microelectronics on the Third World must take these contextual factors into consideration.

One of the most significant of these factors is the phenomena of Third World industrialisation efforts which have led to fairly significant increases in the export of manufactured products. Rates of growth of manufactured exports averaged around 26 per cent per year during the 1970s.

These aggregate growth rates, although impressive, do not necessarily reflect the situation of individual nations, since developing countries are by no means a homogeneous group. Different countries have experienced varying degrees of success in increasing the value and volume of their manufactured exports. This is largely due to differences between countries in terms of the structure of their economies and the orientation of their industrialisation strategies. Underlying these differences are factors likely to be crucial in determining the ability of these countries to respond to changes in trading conditions brought about by the use of MRIs. These factors include the diversity of industrial activities and the size of the internal market; the degree of foreign control, (particularly in sectors where exports are important); the percentage of value added in exports; the degree of integration with local suppliers of intermediates, capital goods, and technical services; the level of indigenous technological capability; and the location of markets for the exported products.

It is difficult at this stage to assess how the combined weight of these variables will influence the impact of microelectronics on individual countries or on the Third World as a whole. Detailed case studies with a strong data base drawn from fieldwork within these countries are required. Nevertheless, a reasonable first approximation of some aspects of the problem

can be developed from the careful monitoring and analysis of the process of innovation and diffusion of MRIs within the advanced industrial economies. The first manifestations of how microelectronics will affect international comparative advantage will be highlighted by the rate and extent of the diffusion process in those developed countries which are either competitors or markets for the Third World.

A major study along these lines is underway at the Science Policy Research Unit, University of Sussex and is focusing on the MRI innovation/diffusion process in the garment sector in a select number of developed countries. The garment sector was selected for study because of its importance to both developed and developing countries in terms of trade and employment (see Table 1). Moreover, the production process in this sector is highly labour intensive.

table 1

International trade in clothing among selected market economy countries (US \$000)

	1969	1977
Hong Kong	620,713	2,935,834
Korea, Republic of	160,691	2,023,675
India	26,916	333,579*
Singapore	27,825	210,879
Mexico	5,639	32,848*
Brazil	737	85,172
Thailand	788	81,827*
Tunisia	620	70,406*
Colombia	916	39,666*
Philippines		79,999*

*1976 data

Source: United Nations, *Yearbook of International Trade Statistics, 1977*, vol II, New York, 1978, p 183.

A common argument in the literature is that such processes are particularly susceptible to cost reducing innovations based on micro-processors which would

allow full automation and dramatically reduce labour inputs. Private sector firms in the developed countries are expected to be the first to introduce these innovations. It is alleged that this would improve their competitive position *vis-à-vis* Third World producers and deprive developing countries of crucial export markets.

Given that the apparel industry shares some similarity with shoes, textiles and other labour intensive sectors, it was felt that a detailed examination of developments in the industry would provide valuable insights at a more general as well as at the specific level. In the next section we briefly review the nature of the production process (prior to the introduction of microelectronics) and some of the structural and institutional characteristics of the industry. Next, innovations in sewing technology containing microelectronics are described; while in the final section some concluding observations are presented on the implications of these changes for the Third World.

Traditional production technology

The manufacture of garments typically involves a sequence of activities where an operative is required at the interface between material and machine at each stage. (The discrete activities include: design, grade and cut pattern, plan optimised lay, lay and inspect for faults, mark, cut, label and bundle, transport to sewing station, assemble, inspect, press and finish, inspect, pack.) Although the basic steps in the process are the same for all garments, the tremendous variety of wearing apparel that is produced to meet the demands of the fashion-conscious consumer in the developed countries in fact imposes widely differing operating parameters from garment to garment. In some cases, such as jean manufacture, production runs are long. Only a relatively few pieces of material need to be sewn together to make the jeans, the sewing tasks are straightforward and style changes are comparatively few. In ladies' clothing, however, the situation is precisely the opposite; there are many style changes, short runs, complicated sewing tasks are required to accommodate design changes, and there are frequently many pieces to be assembled.

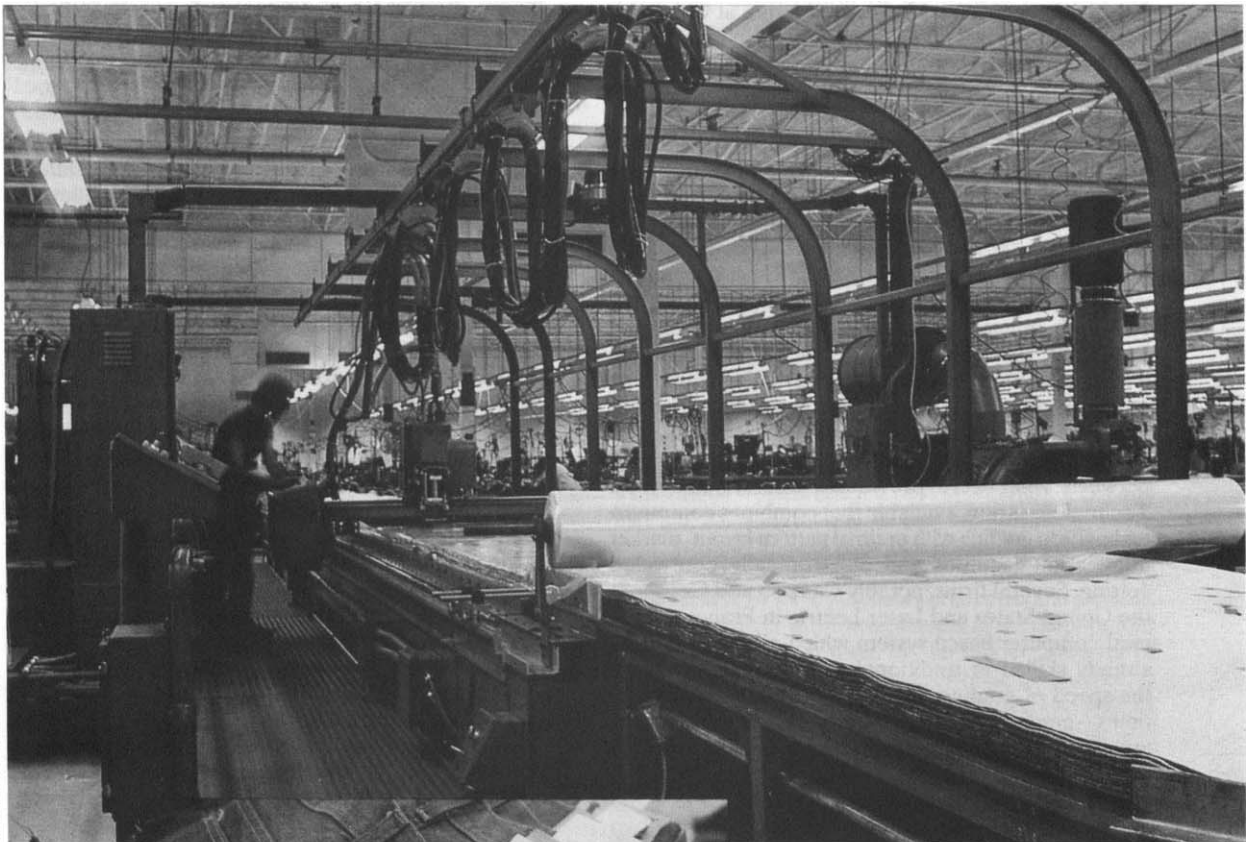
In the face of these conditions, the industry historically has relied upon highly skilled operatives and reliable, inexpensive, all purpose sewing machines which can be cheaply and quickly adapted to the different sewing requirements for each type of garment. The rate at which innovations have been introduced into the industry has been much slower than in other sectors. The basic sewing machine design, which still predominates, is almost identical to the industrial machines of 50 years ago!

There are many reasons for this slow rate of technical change, the major one being the continuing ability of highly skilled manual operatives to respond quickly and efficiently to the technical demands of rapid style changes. However, there are other factors—the industry is highly fragmented, very undercapitalised and, apart from the large firms, is burdened with archaic management practices. Equally as problematic as these institutional obstacles are some significant technical barriers to innovation which centre around the problems of handling the 'limp' fabrics which make up garments. As we shall see, since the average rate of investment in R and D in the apparel industry is very low (about 0.05 per cent of sales) and the capital cost of overcoming these problems very large, prior to the advent of (micro)electronics there has not been much progress towards their solution.

As a result of these structural and technical characteristics of the industry in the developed countries, the level of technology in use by Third World manufacturers is roughly on par with that employed in the advanced industrial economies—certainly the gap between best practice techniques and the average production methods in use in developing countries is much smaller in the garment sector than in other sectors. Consequently, relative labour costs have been the main determinant of competitive position, although quality factors have so far prevented developing countries from competing internationally in some lines of apparel. Due to low wage rates, Third World manufacturers have enjoyed an increasing degree of comparative advantage in a number of high volume sub-sectors as wages have risen in the West.

Although technical change has, as stated above, been relatively slow in the industry, during the 1950s, 1960s and early 1970s the introduction of electronic controls allowed for continuous, if modest, increases in productivity for specific sub-processes now carried out by specialised machines. Due to the relatively high capital costs of these specialised machines, now costing thousands of dollars as opposed to the average cost of \$600 for a standard sewing machine, the comparative advantage of less developed countries has remained intact. The differential in labour costs is substantial—with US 100, the UK 40, Japan 20, Hong Kong 10 and Taiwan and South Korea 5. This differential has remained so that a large number of international firms have located an increasing proportion of assembly in low-wage countries either through sub-contracting, joint ventures or wholly owned subsidiaries.

The introduction of microelectronics in the late 1970s raised the expectations of some observers, both inside and outside of the industry, that the formidable technical obstacles to automation would be removed. It was felt



Computer aided pattern cutter used in manufacture of jeans.

that the microprocessor, with its vast information processing capacity and inherent flexibility had the capacity to facilitate radical technical changes at the sub-process and systems level.

While the changes that were widely predicted have yet to advance beyond the first generation of innovations, the awareness and interest of the industry in advanced industrial nations has certainly been captivated. Within the last three years the number of capital goods firms offering microelectronic controls

in their sewing machines has increased from less than a half dozen to over 25. In addition, firms and individuals from outside the industry, who have extensive experience in electronics, have introduced the most radically new innovations in garment technology.

Microelectronics-based technologies

Below we briefly describe some of these innovations. There seems little doubt that these and subsequent innovations will eventually dramatically alter the structure and character of the industry in the advanced

industrial economies. However, the rate at which this transformation will take place is still open to question, given the deeply rooted and inbred nature of some of the structural and institutional problems referred to above.

Grading, laying out, marker making, and cutting have traditionally been separate and highly skilled manual tasks. Given the value of the cloth in total costs of the finished product (often reaching 50 per cent), the phase of laying out patterns on the cloth is crucial if wastage is to be kept to a minimum. Likewise, cutting the cloth precisely according to the lay is equally important, particularly since error at this stage can lead to defective garments at the assembly stage. The sequence of tasks from grading through to cutting has been the only operation for which automation with microelectronics has significantly bridged the gap between what were previously discrete activities. Technology is now available that combines computerised pattern grading with optimal pattern layout, marker duplication facilities and electronically controlled cutting. Several firms, notably Camasco and Gerber in the United States and Laser Lectric in France offer a mini computer-based system which allows operators already skilled in traditional techniques to increase the speed of grading and laying out from two to six times—grading which previously took four days now takes only one hour—while simultaneously reducing waste from between two to five per cent. When the value of fabric usage runs as high as \$10 mn as is the case in a number of medium sized firms, even a two per cent fabric savings is substantial considering the low profit margin per unit. The outright purchase of these systems, however, costs between \$300,000 and \$600,000 and necessitates maintenance contracts in the range of \$1,800-\$2,600 per month. Not surprisingly, the sizeable initial investment and the high fixed and running costs have led to the establishment of service bureaux which offer these services to users who cannot justify purchasing the systems themselves.

Cutting technology, having remained static until the early 1970s has moved from a manual technique using a hand held electrical or mechanical knife to completely mechanical cutting that is electronically controlled. A decade of experience has seen the virtual demise of automatic dye cutting, as well as the use of lasers and high speed water-jets to perform cutting. These have largely been superseded technically by the Gerber computer controlled cutter, which incorporates a self sharpening blade. This machine, which requires complete re-engineering of the cutting room to attain maximum efficiencies, costs around \$600,000-\$1,000,000 and employs the programming facilities offered by the Camasco or Gerber marker makers described above. This has greatly reduced the time involved in these phases of the process from about one

hour to a (maximum) of four minutes per suit. Skilled labour input is reduced dramatically with savings of up to 1000 per cent reported by some firms in their marking and cutting workforce.

Although technologically impressive, these innovations are associated with activities which give only limited increases to value added. And given the high level of investment required these can only be afforded by the larger firms.

While the value of fabric is a major proportion of final costs these costs are comparable for manufacturers worldwide. It is in the area of reducing labour costs in the assembly stage, accounting for about 80 per cent of all labour costs, where savings are required, if any dramatic shifts in comparative advantage in favour of the developed countries are to occur. The technical changes which have occurred in the sewing room, while significant for certain sub-processes, are nowhere near the same magnitude as seen in the earlier phases of the garment manufacturing process.

The range of different sewing tasks that need to be carried out at the assembly stage is very wide and can involve complicated stitches requiring a very great deal of skill. In most cases, highly irregular shapes of different lengths are involved—all of which change as fashions vary. To compound the problem, many factories are required to make only a few units of the same size and shape at any one time, and often have to mix batches and orders.

The technical problems for mechanising and automating such a process are as obvious as they are formidable. The use of microelectronics has, however, allowed for two types of semi-automatic sewing which although they do not completely replace the operator, do increase productivity while at the same time reducing skill levels and training time. The first incorporates a dedicated microprocessor in specialised pieces of equipment for small parts assembly ie collars, cuffs, belt loops and pocket setting. These machines produced by a wide range of firms including Union Special, Pfaff, Durkoff, Neechi, Juki and Reece, cost in the range of \$15,000-40,000, and allow a *high volume* producer to increase productivity by anywhere from 50-300 per cent by increasing the speed and combining a number of operations, eg in the case of collar attachment, these machines reduce the number of operations from 11 to 3.

Long runs, infrequent style changes and more than one operating shift are necessary for these reliable, extremely efficient, but relatively inflexible machines. The second category of sewing innovations are distinguished by the use of programmable memory chips. At \$5,000-\$8,000 these machines can be computer

programmed and controlled to perform a large variety of stitches in either decorative or functional sewing tasks. When combined with photo-electric edge-sensing equipment, these machines will monitor the edge of the material to be sewn and disengage the needle when required. One leading manufacturer quotes an independent evaluation of this system which claims that productivity is improved between 25-66 per cent for a variety of operations such as top stitching collars, setting shirt pockets and attaching collars.

With approximately 80 per cent of the average garment manufacturer's labour and capital costs associated

with the assembly phase, the subsequent concentration of innovative activity in that area is justified. Given the current technical difficulties and potential savings in the sewing room it is also hardly surprising that the finishing stage has been relatively neglected. This is reinforced by the pervasive attitude among management that the function of pressing is primarily in making the product 'presentable' or 'saleable' rather than an essential component of value added.

This attitude is likely to change as modernisation in the industry fosters more sophisticated methods of cost justification. Two capital equipment manufacturers



Beta Engineering and Development Ltd.

Microprocessor controlled sewing machine.

recognising that the 10 per cent of capital expenditure estimated for this stage also signifies a high degree of labour intensity, have now incorporated microelectronics into their pressing equipment.

Magpi/Sussman and Certus have introduced first generation pressing equipment for jeans, slacks and suits which incorporates microelectronics. In flat pressing jeans using this equipment, six pairs of jeans can be pressed per minute, or over 2,000 pairs per day, while suits can be pressed at the rate of 400 per day. While Certus' equipment goes some way towards providing a more continuous pressing of separate parts of a garment (ie sleeves, armholes, shoulders etc) and Sussman's allows the operator to choose from 12 pressing variables (ie steam pressure, temperature, etc) neither machine, whose cost ranges from \$30,000-\$200,000, have operated under production conditions long enough for an accurate assessment of their operating performance. What is currently evident is that for a limited number of products (jackets, jeans) these machines can be used to reduce both training times and the skill of the operator, previously required to ensure quality.

Implications for the Third World

While the fully automated garment production system is not at present a reality, the trends in technical change and the expectations in the industry are unmistakably oriented in the direction of increasingly comprehensive systems development—although it is likely that change will continue to be gradual rather than rapid—extending into medium to long term as opposed to the overnight changes predicted by some observers.

The structural and institutional problems discussed earlier which impeded the historical rate of technical change, will also slow the rate at which MRIs are introduced by manufacturers in the developed countries. The high capital costs of the systems and the advanced management and maintenance skills required to operate them efficiently mean that the large manufacturers will be best placed to use the equipment. Interestingly, these large firms are also those most heavily involved in offshore manufacturing and producing under USA 807.00 import type clauses. Hence, they will be able to gauge very accurately the relative costs of producing garments offshore using cheap foreign labour as opposed to home based production using advanced technology.

Although it has not happened yet, to any great extent, there is a feeling among the large producers that a large share of offshore production will be brought back. In those cases where these firms have located manufacturing facilities in developing countries with

large domestic markets, we would expect that the equipment would be introduced if competitive conditions required such a move.

Both of these scenarios have significant implications for developing countries.

Locally owned Third World firms produce and export an extremely wide range of garments that vary enormously in terms of quality and cost. Traditionally, they have concentrated their efforts on standardised products of low to medium quality which have a wide demand in western countries—blue jeans, skirts, blouses, shirts, jackets, etc. More recently, however, they have been successfully moving 'up market' with their exports and are increasingly competing with developed country producers in high fashion sub-sectors such as suits and dresses, where profit rates are higher and there are fewer tariff barriers. Their comparative advantage, however, remains based on cheap labour rather than on improved technological capability.

Although Third World firms do have access to quite a large range of techniques on the international machinery market, they tend to rely extensively on conventional multipurpose machines and cheap labour to perform manually the tasks which will become increasingly automated in the developed economies. This combination gives them the capacity to mass produce standardised products at low prices and enables them to respond quickly to ever changing fashion requirements and competitive conditions. These characteristics will allow Third World producers to resist the effects of microelectronic based technical change. But this ability to resist must gradually be eroded by the combined effects of rising domestic wages, higher and broader tariff barriers and innovations increasingly directed at precisely the activities where they now enjoy comparative advantage. As we have already mentioned, the crucial variables in this process will be the rate at which these applications will be developed and their speed of diffusion within the advanced industrial countries. Across sub-sectors, this will be an irregular and discontinuous but nevertheless inexorable process that is already signposted by current developments.

Such a process will create problems for some Third World producers, particularly those countries which are really only beginning to develop their apparel industries. The renewed strength of western manufacturers and the already entrenched position of the more advanced developing countries will work against any dramatic expansion of market opportunities for the least developed countries of the sort that fuelled industrialisation for the NICs. However, the die is not yet cast and some time will elapse before these changes

really begin to take effect. In the intervening period, these poorer developing countries will need to make a much clearer assessment of their strategies to develop

the garment sector in the light of the effects of micro-electronics on the structure of the industry in western economies.