OCCASION

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

DISCLAIMER

FAIR USE POLICY

CONTACT

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

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

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

17305

United Nations Industrial Development Organization

EXPERT GROUP MEETING ON PROSPECTS FOR INDUSTRIALIZATION POLICIES IN DEVELOPING COUNTRIES TAKING INTO ACCOUNT THE IMPACT OF DEVELOPMENTS IN THE FIELD OF NEW AND HIGH TECHNOLOGIES

Vienna, Austria, 4-7 April 1989

Technology Case Study No. 2

TECHNOLOGICAL AND ORGANIZATIONAL CHANGE IN THE GLOBAL TEXTILE-CLOTHING INDUSTRY

Implications for Industrial Policy in Developing Countries

Prepared by Kurt Hoffman
UNIDO Consultant

DRAFT WORKING PAPER
FOR PARTICIPANTS ONLY

14/

Table of Contents

I. CONTEXT OF THE STUDY

1. Textile and clothing industry in North-South economic relations

The textile-clothing complex has historically played a crucial role in the industrial development strategies of many Third World Countries. The clothing segment was the first manufacturing branch that achieved a rapid growth of exports to the industrialized countries increasing by more than 20% annually between 1968 and 1978. The accompanying expansion in clothing output (7 % annually during the 1970s), based initially on imported fabrics, in turn stimulated the development of a textile industry in a number of countries. Textile exports to the industrialized countries also expanded rapidly with the consequence that the developing countries' share of world trade in textiles and clothing more than doubled from 16.4% in 1965 to 42.1% in 1985. Despite the growth of output and exports from other industrial branches textiles and clothing have remained important to the Third World, accounting for 4.5% of total manufactured output and over 35% of manufactured exports.

As is well known, the newly industrializing countries (NICs) in Asia, particularly Hong Kong, the Republic of Korea and Taiwan Province of China were by far the largest textile-clothing exporters during the 1960s and 1970s, on average contributing more than 75% of total Third World exports over that period. There is little doubt that the NICs' early industrialization efforts benefitted substantially from the dynamic export-oriented expansion of their clothing industry.

While this is significant in itself, the "demonstration" effects of the NIC success in exporting to the industrialized countries (and in subsequently diversifying into other labour-intensive manufactures) has been much more important. Many other developing countries were persuaded by the NIC experience to pursue the establishment of export-oriented textile-clothing production in the 1970s in the hopes that they could follow the same path to export-led growth and industrial development.

This pattern of rapid export growth, first by the NICs and then by a much larger group of smaller economies was the source of considerable problems for the industrialized countries who saw their combined share of world clothing exports drop from 65% in 1965 to 40% in 1985. By 1984, developing countries' clothing exports accounted for 50% of OECD imports of $39 million, with 65% of these going to the US and Canada and 29% to Europe. The US alone imported $17.7 billion worth of clothes from the Third World in 1987, accounting for 23% of their domestic market.

Not surprisingly, the initial success of the NICs followed by a much larger group of countries in their footsteps has long been one of the key sources of tension in North-South trading relations. Developing country exports have been blamed by industrialists and trade unionists in the North for the precipitious contraction of employment in the industry over the last 20 years during which time total job losses have exceeded 3 million. However, Thirld World exports of textiles and clothing have by no means been entirely responsible for the loss of employment in the industry in the North. Nevertheless, starting as far back as 1962, tariff and non-tariff barriers imposed by the industrialized countries and directed at excluding textiles and clothing produced in developing countries from the domestic market have

continually risen in level and scope. The distorting effects of this protectionist response have been well documented - and to this day and for the foreseeable future, OECD trade barriers will remain the single most important factor determining the scale and distribution of North-South trade in textiles and clothing.

2. The changing importance of technology and non-technology factors as determinants of international competitiveness

Trade barriers have by no means totally removed the threat of low wage imports since for most countries, particularly the US, these barriers have been "permeable" rather than absolute, controlling the rate of growth of imports rather than halting them altogether. Thus since the mid-late 1970s, a sentiment has been growing that the textile-clothing industry in the OECD can only survive and prosper by increasing its competitiveness via the development of new and substantially more efficient production techniques. Manufacturers and capital goods suppliers have become increasingly preoccupied with the search for cost reductions via technological change.

Given this perception, it is not surprising that the emergence of microelectronics technology in the late 1970s attracted a great deal of interest and attention both within the OECD clothing industry and by observers, analysts and policy makers concerned with industrial development in the Third World. This concern arose because of the evidence that emerged early in this decade that the application of microelectronics to the automation of industrial processes could lead to significant reductions in labour inputs per unit of output and a corresponding reduction in labour costs as a share of total costs.

Accordingly, it was feared that the productive gains arising from the rapid diffusion of microelectronics-based innovations in the North could undermine the low wage-based comparative advantage of developing countries across a broad range of product categories, particularly in low-technology sectors such as textiles and clothing. There was widespread concern that there would be a rapid and major degree of trade reversal or relocation involving substitution of domestically produced products in the North for those previously imported from developing countries. Given the importance of this sector, the application and diffusion of microelectronics to textile-clothing technology was consequently viewed as a major threat to trade, employment and indeed the prospects for industrial development in a large number of developing countries.

Some ten years have passed since these concerns were first raised about automation and trade reversal in the textile-clothing industry. The reality of what has actually happened over this period both on the technological front and in relation to trading patterns both confirms and contradicts these initial concerns. Technological change has affected North-South trading patterns in the sector - but primarily in textiles and in clothing, where the most important innovations have only recently begun to feature the extensive use of microelectronics and computing technology. The full automation of clothing production in the North and the threat this would imply to developing country exports could still become a reality in the near future. However, it is unclear when this future will arrive - the fears of ten years ago that this would happen virtually overnight have proved unfounded.

However, much more importantly from the point of view of industrial policy, other factors and trends have emerged which are now of equal if not more importance than technical factors in determining international

competitiveness in the textile-clothing sector and the pattern of North-South trade. There have been fundamental changes in the structure and nature of the market for both intermediate products (yarn and textiles) and final products (garments).

This alteration in the character of demand has sparked off a dramatic shift in the marketing and product strategies of retailers and manufacturers, and in turn stimulated a wave a major innovations in the way production is organized within the firms and in the relationships between buyers and sellers. These non-technology induced changes have already had a significant impact on the relative competititiveness of different firms and countries in the OECD and are just now starting to affect developing country trading patterns. However, unlike the genuine although still distant threat posed by automation, the impact of these new factors on developing country export prospects now and in the future need not be negative by any means.

Both the technology and non-technology determinants of trade and competitiveness in textiles and clothing are closely interrelated. Industrial policy for the development of the textile-clothing sector must take into account all of these elements in a comprehensive manner and cannot focus on technology alone. This is the main area of concern of this paper.

Its principle focus is on understanding and responding to the technology and non-technology determinants of international trade and competitiveness in the clothing sector. However, developments in the textile sector are of interest because it is here where we see the clearest examples of the impact of technological change on North-South trade. This is discussed in Chapter II. The third chapter discusses current and future developments in clothing technology and makes the case for a careful monitoring of future trends. Chapter IV sets out to demonstrate the new and growing importance of firm strategies towards greater diversity, flexibility and responsiveness and the impact of these on inter and intra-firm production organization. The final chapter explores their wider implications for industrial development in the Third World.

II. TECHNICAL CHANGE AND INTERNATIONAL COMPETITIVENESS IN THE TEXTILE INDUSTRY

During the 1960s and 1970s, the successful diversification of a select group of Asian economies and some large Latin American countries from clothing production into textile production and the rapid expansion of textile exports from these countries to the industrialized countries indicated yet another opportunity for other developing countries to industrialize by exploiting their low wage competitive advantage at the expense of domestic textile producers in the North. Yet, in direct response to this threat, the textile industry in the industrialized countries, beginning in the late 1960s, embarked on a massive wave of investment in new technology coupled with structural change and a marked-driven industrial strategy. These developments have significantly altered their future prospects in a positive direction - while at the same time raising considerable obstacles to the continued success of developing countries as textile exporters.

The progressive automation of virtually the entire textile production process has been underway for some time, and in some segments is quite far advanced compared to other sectors. This wave of innovation has had

multi-dimensional effects across three inter-linked areas of performance: the reduction of labour content in the production process; increased product quality; and much greater flexibility in production. Dramatic improvement in all these areas has taken place in all the main phases of textile manufacturing - with all of these developments having direct implications for developing countries.

1. Technological innovation in the textiles industry

The sources of productivity growth and other performance improvements have been many and varied, covering a wide range of new technologies both specific to textiles and dependent on innovations from outside the sector, particularly microelectronics and information technology in more recent years. These advances have occurred in both synthetic and natural fibre-based textiles with equally dramatic results. However, in order to simplify the presentation, the following discussion of technological changes will concentrate on the manufacture of natural fibre textiles.

In the opening rooms, automatic equipment for opening, cleaning, picking and mixing bales of fibre is now being rapidly substituted for manual systems eliminating much of the onerous labour input previously required at this stage. In turn, older, slower carding systems are being replaced by high-speed chute feed systems which eliminate whole segments of labour-intensive activity including doffing, racking, manual transport to the card room and hanging the lap. Overall efficiency improvements of at least 200% have been recorded at this stage.

Improvements in opening room technology have had a profound impact on quality as well through allowing a better and more consistent mix of cottons leading to more uniform and stronger yarn. Likewise, technological change in carding has also had quality effects via the ability to make tighter, closer settings thus achieving a better integration of fibres and reduced weight variation. Yarn quality is also improved due to the presence of few broken threads and from the elimination of thick lap joints.

Spinning has traditionally been the labour-intensive heart of textile production, accounting for 50-70 per cent of all yarn manufacturing costs. Open-ended spinning which first emerged in the mid-1960s eliminates a large number of steps in the spinning production process such as drawing and roving thereby greatly increasing labour productivity, while making change-overs easier as well. This equipment along with spinning attachments such as automatic loaders and yarn-splicers, developed and used extensively in Europe in particular, is now four or five times as fast as conventional ring spinning, as well as allowing the processing of a far lower grade of cotton. Quality gains arise here also because of self-cleaning mechanisms which keep rollers from getting dirty, computerized fault monitoring systems, less manual (more robotic) handling of materials and other improvements which produce higher yields of first quality cloth. Moreover, jet spinning, a relatively recent Japanese innovation, spins yarn even faster than open-ended spinning and does it fine enough for high quality shirting and blouse fabrics.

In weaving, conventional shuttle looms are being replaced by high-speed shuttleless looms (using missiles, rapier, water-jet and air-jets). These looms are now three to tens times more productive than conventional equipment via their much greater speed and an ability to produce broader widths.

Better quality is visible via dramatic increases in first quality woven cut lengths, twice as long as with conventional technology. Defects are eliminated through the automated removal of bad picks in the cloth, the repair of broken threads without leaving starting marks, and through perfectly woven, closed selvedges. The high pace of change in weaving technology continues - a British firm has developed a high-speed multiple rapier machine that weaves from both ends, while a Czech firm has a machine that weaves two fabrics at once.

There have been less gains from computer technology so far in terms of flexibility in weaving but there are examples where it has been applied with great success - in one US plant, computer control and automated materials handling devices allow production of 1.2 million yards of fabric per week in 300 different styles, compared to 300,000 yards a week and 100 different styles without the computer.

Radical technological change is visible elsewhere throughout the textile sector including, of course, the extensive use of computers in all phases of production management, financial matters, marketing, communication, etc. In some segments of the knitting sector, for example, automated knitting equipment capable of producing finished garments is increasingly common, as is the use of programmable knitting machines which allow changeovers to new styles to be accomplished in a matter of minutes.

Some of the most advanced applications of computer technology in the industry are to be found in the dyeing and finishing stages where firms are exploiting the flexibility of the technology to respond to growing demands for short re-orders and variation. One European firm has jet dyeing equipment that can handle lots under 500 yards whereas the standard technolology of only a few years ago could handle only a minimum of 10,000 yards. Computer-controlled dyeing has also greatly improved quality as well as allowing precise colour matching when moving from batch to batch or producing to reorder.

Other examples of current computer applications range from the increasingly extensive use of CAD in the design stage feeding through into direct instructions for weaving machines; to computer-controlled, automated carpet-tufting machines; and finally to fully automated inventory systems where computer-directed sensors and robots operate fabric warehouses by keeping track of thousands of items and automatically filling orders for despatch as they are received.

2. Rationalization and new product strategies

Pervasive technological change has been accompanied by equally extensive rationalization measures on the part of the industry that were in many cases facilitated by major programmes of government support for this adjustment process (and which also included substantial subsidies/incentives for investment in the new equipment that was being developed). The deep involvement of the public sector in the restructuring efforts of their textile industries is a point to remember now that many OECD governments are so vigorously preaching the benefits of non-intervention to developing countries.

Apart from major investment programmes in new technology, the rationalization moves pursued by Northern textiles producers, inter alia, involved: better integration of the design, spinning, weaving and finishing stages; the closure of old plants and dismissal of workers when productive capacity outran demand; and finally a large number of bankruptcies.

Perhaps most importantly, OECD textile manufacturers also vigorously pursued a variety of new marketing and production strategies explicitly designed to improve their international competitiveness in the face of low wage competition from developing countries. These strategies all differ in specifics but mostly represent a shift away from mass production of standardized products towards the production of smaller runs of more highly styled products.

Italy, the Federal Republic of Germany and Japan all have textile industries that evolved from a mass production strategy to one based on shorter runs of more sophisticated products to serve highly defined niche markets. All are now highly successful exporters - with Italy and the Federal Republic of Germany now standing at first and second place in the value of textile-apparel exports in the world. The US textile industry has been slower to pursue a niche production strategy but has gone further than the others in exploiting computer technology to reduce unit costs in high-volume production.

The net impact of this wave of technical change and rationalization in the textile sector in industrialized countries has been impressive. Over the last two decades, textile employment in the North has been reduced from 8.9 million to 6.8 million. In turn, because of the higher capital costs of the new equipment - a shuttleless loom in 1982 cost 3.5 times a flyshuttle loom in 1950, a ring spinning mill is 5 times more capital intensive per worker - the textile industry in the developed countries is now a capital-intensive industry.

Underlying these changes have been signficant improvements in productivity. A modern spinning room is almost completely empty of people. Already by 1983, 7 out of 8 new looms installed in developed countries were shuttleless. As a result, in the US, during the fifteen-year period between 1972 and 1987, labour productivity in textiles has risen by about 90 per cent - roughly double the rate at which productivity grew in manufacturing as a whole. Consequently, and helped recently by the fall of the dollar, US unit labour costs now compare favourably with those of its European competitors and of Japan (which have themselves been declining due to labour-saving innovation), and in a number of cases US producers have begun to reach price levels approaching those in much lower cost Asian and Mediterannean economies.

3. Impact on the competitive position of developing countries

In assessing the implications of these developments for developing countries, a number of points need to be noted. Firstly, while there has not been a massive rollback of the trading gains made by developing countries in the textile sector in the 1960s and early 1970s, neither has there been the expected expansion and subsequent destruction of textiles procedures in the North by exports from the South. On the contrary, having survived the initial onslaught largely by hiding behind protectionist barriers, Northern producers

are now beginning to reap the benefits of their investment in new technology - gains that in future could be extracted at the expense of the developing countries.

Moreover, recent changes in the pattern of market demand have played right into the hands of the Northern producers and their new technological base. The textile technology now in place is well suited to allow producers to respond to pervasive changes in demand which are now driving the market - more frequent style changes, greater emphasis on design and styling, shorter runs, and the use of finer yarns and more lightweight fabrics. In short, the greatly increased strength of the automating textile industry in the OECD countries has already introduced a permanent constraint on the textile export aspirations of the large majority of developing countries.

Recent work by UNIDO has shown conclusively that with the exception of relatively few countries, the success of the North in modernizing its industry and regaining comparative advantage (coupled with widespread and severe protectionist measures) has prevented most of the poorer countries from making the heretofore expected shift to textile exporters based on an integrated textile-clothing complex and mass production for undifferentiated markets.[1/]

Instead, because of the growing competitiveness of the North, many have remained "stuck" as clothing exporters and the process of transition to textile exporting on which so many hopes were based has run out of steam since the mid-1970s. This process of backward integration via export expansion into western markets is unlikely for most of these countries to restart in the near future if at all.

This is particularly the case in those segments where new product lines have been developed and where international competitiveness is now based on high technology and the ability to produce in small lots. In the whole of the European textile market, there now appears to be little if any competition from developing country exports in these market segments. Indeed, some countries such as the Philippines, Sri Lanka and Thailand have in recent years moved from being net exporters of textiles to net importers of OECD textiles in these categories.

In sum, because of technological change, government support, a new product mix and the niche marketing strategies pursued by Northern producers, a major component in the textile-clothing-export equation that historically had been expected to be the first step in industrialization for many countries has now been effectively eliminated.

Nevertheless the wage gap between the OECD countries, NICs and other developing countries remains substantial in the textile sector. As a result of this traditional competitive advantage and because of the growing capital costs of the new equipment, most developing countries still rely on the labour-intensive spinning and weaving technologies of the 1960s. This might make sense in narrow economic terms by allowing them to retain existing markets for "undifferentiated" commodity-type fabrics and yarns that are low cost and also low value-added products. However, it does mean that these countries are inevitably falling even faster and even further behind the world technological frontier both in this product segment, and more importantly in

the fast growing segment of "differentiated", specialty-type fabrics and yarns where the North has gained the technological and marketing edge.

In addition, it needs to be borne in mind that while microelectronics has played a role in the textile innovation process over the last twenty years, this role has been comparatively limited compared to the impact it has had in some other sectors. Moreover, where the technology has been introduced, it has been used to assist the automation of specific stages of the production process via the design of custom-engineered machinery built to do a specific task - i.e. hard automation. The vast potential of the technology to facilitate systemic integration of the production process, coupled with much greater flexibility than is already possible, has not yet been fully exploited.

Accordingly, most observers expect that the innovation process has by no means slowed down but will in fact continue apace with one important difference to that which has occurred so far. In future, technological change in textiles is much more likely to be driven by the pervasive search for flexible, systemic, integrative applications of information technology than by the search for hard automation tied to the mass production of standardized products.

Three areas where this sort of change is expected are materials transfer, inspection, process and management control. Spinning frames will be much more flexible in terms of changeover; they will be served by high mobility transfer devices carrying output to different locations. Inspection will take place throughout the process using rapid response, vision and/or tactile systems as well as transducers to measure physical properties.

Product, process and output specifications will be able to be altered almost instantaneously in response to changing plant configuration and customer preferences. This will be manifest for instance in complete dye house automation allowing for rapid change and computerized integration between dyeing and finishing. CAD technology used in design and scheduling will generate the manufacturing and marketing data-base needed to drive the system and allow much greater and closer integration with apparel producers.

Such developments are expected in spinning, weaving and knitting. Their likely impacts on productivity, quality and hence on international competitiveness and the current pattern of North-South trade in textiles can only be guessed at but are likely to be signficant - perhaps as significant as those that have already occurred.

These short- and long-term factors taken together basically mean that the poorer countries, though retaining some competitive advantage in certain segments such as lower cost commodity fabrics, including unfinished fabrics, will be less and less able to expand their export production at the expense of producers in the developed countries - though tariff-induced distortions in international trading patterns mean that their textile exports should continue to grow slowly at the expense of the NICs. Any real growth will only come from expansion of their domestic and regional markets - where they will inevitably come under further Western pressure in the future to open up these markets.

The Asian NICs and large country exporters, on the other hand, while enjoying continued strength as textile exporters face other problems. They

have begun to invest in modern technology but are still some ways behind the installed capacity of the Northern competitors. This investment, coupled with relatively low wages, has largely preserved their market share (won in the halycon days of the 1960s and 70s) so far. But the rapid and continuing pace of technological change in the North, the constraining effect of protection and the ever-present threat from lower wage countries, means they must pursue technological upgrading aggressively or risk falling behind and losing ground rapidly to their competitors in North and South. As the systems become more progressively integrated, this will become a more and more difficult task.

China, of course, poses problems to all other players - the developed countries, the NICs and the poorer countries. In textiles, as well as clothing, China's competitive position in the international arena is greatly bolstered by the combination of extremely low wages, a massive modernization programme, a large market and considerable political clout with the North in the quota struggles. However, there are no guarantees that China will fulfill all of its potential. Competition is fierce and it will be by no means an easy, quick or costless task for the Chinese textile industry to master modern, computer-based, integrated textile technology.

4. Some broad policy implications

Three points summarize what has been said so far.

- First, technological change has clearly already had a major impact on international competitiveness in the textile sector.

- Second, there is no way of knowing how quickly the systemic innovations that are beginning to emerge in the North will actually diffuse, nor how quickly these will further enhance developed countries' ability to compete internationally. This may occur more rapidly than in the past - or conceivably more slowly; good arguments can be mounted for both viewpoints.

- Third, there is no doubt, that further, technology-driven changes in the determinants of international competitiveness will come to the textile sector.

Faced with a slowly growing export market, defended by Northern producers now able to generate continual and substantial improvements in productivity, quality and responsiveness to market demands, all developing country producers will find that they cannot afford to stand still in technological terms but in fact will have to invest and modernize as quickly as possible simply in order to stay in the same place.

The policy implications derived from this assessment cannot be deduced in isolation. They must emerge out of a well-planned restructuring and modernization strategy that sets out its objectives in terms of scale, products, marketing strategies and arrangements, efficiency levels, technology base and industry structure. Such a strategy can only be developed on the basis of a thorough examination of the current status and future possibilities of the domestic textile industry. Among the factors to be taken account of in such an assessment would be product prices, product mix, quality, volume and output levels, relative factor costs and production cost structures compared against international standards and emerging trends.

The industry structure would also need to be assessed, again against international standards, in order to categorize firms according to their volume, product mix, technology base, productivity, quality, delivery and response capabilities, financial profitability, investment performance, rehabilitation and modernization needs and potential, and perhaps most importantly the innovativeness and competence of firm management in areas such as marketing, design, technology and production management.

A modernization strategy of necessity would incorporate a wide range of policies and programmes that go well beyond technological issues - fiscal policies, trade policies, support for restructuring and diversification, export promotion policies, input subsidies, forward and backward linkages to the raw materials and clothing industries, institutional and conceivably sector-wide initiatives for training, marketing information, design, etc.

Focussing solely on the technological components of the modernization strategy, it would need to incorporate three elements. First and foremost, the problems of "x-inefficiency" have to be addressed. There is widespread evidence that textile firms in many countries are managed poorly and have apalling productivity records.[2/] Both of these failings represent major constraints on competitiveness.

Consequently, firm technological and managerial capacities to organize and run production efficiently and to generate a continual stream of productivity improvements from existing equipment will have to be strengthened through in-house training programmes and some form of externally organized training for managers and engineers. Many of the points raised later in chapters IV and V about the need to introduce new methods of production organization and management will be relevant here.

Second, a programme of sector-wide fiscal and other incentives designed to stimulate investment in efficiency improvements and in the purchase of new equipment would have to be designed. This could be accompanied by a sector-supported information unit to provide up-to-date information on available technology choices and their appropriateness for local conditions and the objectives of the sector modernization strategy. Beyond that demonstration projects/centres/firms might also be supported to increase firm awareness of the technology choices available and their impacts on performance and competitiveness.

The technology choices available on the international market are still quite wide even though there has been relatively little specific R&D aimed at developing state-of-the-art equipment specificially suited for developing countries. One possible technological factor working in favour of developing countries over the longer term is the trend towards computer-based equipment that is both more flexible and cost-effective at lower volumes of output. This possibility needs to be examined closely however for its relevance in the specific circumstances of individual countries.

Finally, because of limited resources, selectivity may have to be exercised in the provision of firm-specific financial and technical support in the area of new technology choice, purchase, installation, operation and maintenance. This strategy is not without its risks however and needs to be carefully considered in light of the structure of the industry, how well local markets operate and the economic strength and technological and managerial capacities of the firm.

Inherent in the logic of any textile restructuring programme pursued by developing countries in the current industrial climate will be the necessity to make difficult choices that when implemented are likely to have painful, and potentially politically costly implications for the economy, individual firms and workers.

Facing up to these choices and taking the actions called for cannot be avoided - even though it may mean in the end that previously ambitious assumptions about growth rates, foreign exchange earnings and employment have to be abandoned along with a sizeable segment of industry capacity and workforce. To do nothing or assume that conditions will stay as they are is tantamount to permanently relegating a country to the lowest rung of the international textile ladder with no guarantee that it will be able to maintain its hold as a viable exporter over the longer term.

III. THE UNFULFILLED PROMISE AND LONG-TERM POTENTIAL OF RADICAL TECHNICAL CHANGE IN THE CLOTHING INDUSTRY

1. The basic structure of the clothing industry

In the clothing industry there is a unique but straightforward relationship between the product, the production process, industry structure and competitiveness. This relationship not only explains the international division of labour and the pattern of North-South trade in the sector; it is also the key determinant of the short- and long-term impact of microelectronics technology on the role of developing countries as major exporters of clothes.

The clothing production process involves distinct activities that can be grouped under three headings - pre-assembly when the garments are designed, patterns are made and individual components (sleeves, pockets, front and back panels) are cut from cloth; assembly when the components are sewn together into the finished garment; and finishing when the garment is pressed, packaged and despatched.

Of these, the assembly stage is by far the most important since it accounts for 80% of value added in clothing manufacture and involves 80% of the workforce. The interaction between operator, machine and material is the critical feature. Sewing machine operators are highly dextrous and once trained can handle a wide variety of sewing tasks. The basic piece of equipment used in assembly is a standard industrial sewing machine that is low cost ($200 - $1,500), robust, simple to operate and easy to maintain and adapt to specific operations.

Through many minor innovations and small improvements, the sewing machine can now stitch two to three times faster than it did 50 years ago - just about to the limit of a human operator's abilityy to guide material under the sewing head. The combination of a flexible operator and a low cost flexible machine remains the dominant production unit in the assembly stage in clothing factories all over the world.

Clothes are made from "limp" fabrics that have unstable and highly variable handling characteristics that necessitate extensive manual positioning by the sewing machine operator. Because of this, it has historically proved extremely difficult to mechanize materials handling. The garment assumes a three dimensional character early in the assembly stage - skilled human operatives can cope with all the variations involved quite easily; machines could not.

Consequently, materials handling by the operator accounts for 80% of the production cycle, with actual sewing time (i.e. when needle and thread passes up and down through the material) accounting for only 20% of the cycle. As a result the rate of output in clothing production is essentially labour-paced. This caracteristic, along with the many styles of clothes produced by the same factory, means production is done in batches, making it difficult to achieve scale economies.

Thus in the clothing industry, where process know-how and production skills are easily mastered and equipment is cheap and widely available, neither technology nor scale economies have ever acted as a barrier to entry as they have in other sectors. Low barriers to entry have, in turn, affected directly the structure of the industry both domestically and internationally. At the national level, ease of entry means that the domestic industry is typically composed of many small firms (under 100 employees) and relatively few large firms. Under these conditions, retailers are able to foster fierce price-based competition, forcing producers to constantly seek to reduce unit costs without imparting flexibility or incurring large expenditure.

At the international level, a similar process underlies the international division of labour in the industry. Firms from both developed and developing countries enjoy equal access to the same range of techniques while also facing roughly similar materials costs. In this situation, unit labour costs become the key to competitive advantage. And because their wages are so much lower than in the North, developing country firms enjoy a substantial degree of cost advantage in many product categories despite higher productivity and other advantages enjoyed by developed countries.

These structural features (determined by the economics and technology of assembly) are characteristic of many segments of the clothing industry. They essentially explain the past and current highly successful export performance of developing countries. They also indicate that if an across-the-board, technology-induced, trade reversal is going to occur, then this will only happen if the assembly stage, with its complex materials handling aspects, can be automated.

So far, even with the computer and robotics technology available today, this has not yet happened - at least not on a sufficiently pervasive scale to affect broad trading patterns. Concerns expressed in the early 1980s about the imminent loss of the Third World's low-wage based competitive advantage have not been fulfilled. This is not to suggest conditions will not change. Indeed, as will be shown below, there are clear signs that the extensive automation of the assembly stage will almost certainly emerge at some time in the future.

However, the pace of automation in the assembly phase - and the threat this poses to developing countries - has been superceded by other developments

on the technological front and by changes in the organization of production and the structure of the market. These developments have more immediate implications every bit as significant from the Third World policy perspective as those arising from the future threat of assembly automation.

In the remainder of this chapter the nature and impact of microelectronics-based technological change in the clothing production process will be discussed. Chapter IV will explore the non-technological factors of changing market demand and organizational innovation that have, somewhat surprisingly emerged as critical determinants of international competitiveness in the clothing industry with wide implications for the Third World.

2. Radical advance and incremental change in clothing technology

It would be a mistake to assume on the basis of the above discussion that microelectronics technology has so far had no impact on the economics of production and international location in the clothing industry. This is not the case as the technology has found application in all stages of the production process - and in some cases these represent state-of-the-art achievements not found in other sectors. The discussion below will concentrate on technological developments in pre-assembly and assembly as these are the stages where the technology has had its greatest effect and where it will have an even greater impact in the future.

a. Systemic automation in pre-assembly

By far the most dramatic changes have occurred in the pre-assembly phase where new, electronics-based capital goods firms have introduced computer-aided design (CAD) and computer-numerical control (CNC) technology. The CAD systems are used for grading patterns (making pattern parts for various sizes) and for marking (laying out the pattern parts as a guide for cutting). By digitizing information regarding the shape and size range of the clothes to be produced, the CAD system uses stored "rules" to quickly and efficiently perform grading and marking tasks previously carried out manually by highly-skilled, well-paid operators.

The other major microelectronics-based innovation in the pre-assembly stage involves the use of CNC guided, fully automated cutting systems that replace manual cutting techniques used previously. In the computer-controlled cutter, digitized information (produced by the CAD system) is used to guide a self-sharpening, reciprocating blade across a cutting table at very high speeds (20 metres/minute) on which many plys (layers) of fabric (up to 300) are compressed and held in place by a vacuum mechanism.

The CAD grading and marking systems and the CNC cutter offer a wide range of benefits. In the case of the CAD systems, while skilled labour input is reduced, by far the most important gains are faster turnaround time in grading and marking (improved by a favor of 4-6 times) and improvements in fabric utilization (up to 15%) due to making "tighter" lays of the patterns on the cloth for cutting - very significant since fabric costs are 40-60% of total costs.

More recently, users have also begun to take more advantage of the greater flexibility offered by CAD systems via their abality to make rapid alterations to styles. Alterations and changes that used to take hours, even days done manually can now be carried out in a matter of minutes. This flexibility offers enormous advantages in a market that, as will be shown, is beginning to demand a rapid response capability from producers far beyond anything required before.

In the case of automated cutters, reductions in skilled labour usage (from 25-60%) are a much more significant benefit, along with better quality (more accurate cutting) and materials saving via closer cutting of more tightly fitting patterns. The biggest gains, however, are from greater output (200-300% improvement) due to higher cutting speeds and the ability to cut more layers of cloth at one time than was possible with manual methods.

Unlike many other industries where the integration of CAD with CNC technology (CAD/CAM) is still proceeding very slowly, clothing manufacturers have had this option open to them since the late 1970s. The CAD/CNC cutter integration in clothing technology thus represents one of the most advanced CAD/CAM applications anywhere in the manufacturing sector. And while savings arising from use of these systems on a stand-alone basis are significant, the systemic gains that arise from their integration are of a much higher order. Most importantly perhaps in the longer term, by establishing a digital data base defining the product, the use of CAD in particular is a critical first step in the automated integration of all phases of the clothing production process.[3/]

These systems are expensive, with prices ranging upwards from $100,000 for a single system to as much as $10 million for a multi-CAD/cutter installation. Nevertheless, diffusion has been relatively rapid, and now over 50% of all clothes produced in the US come from firms using CAD systems and computer-controlled cutters, while more than 65% of all UK firms surveyed in a recent comprehensive diffusion study already have CAD systems and/or cutters installed or on order.[4/] This degree of diffusion represents a fundamental transformation of the pre-assembly stage that is all the more remarkable since the clothing industry has traditionally been very loathe to invest heavily in new technology of any kind - let alone buying systems costing an average of $250,000 to replace equipment costing a few thousand dollars at most.

The process of change continues in pre-assembly technology. Most importantly, the unit cost of these sytems is coming down and will continue to do so as patents expire, new suppliers enter the market and manufacturers target smaller companies. Moreover, both cutters and CAD systems are being improved in a variety of ways while automation is being extended to other parts of pre-assembly - CAD systems capable of true design work depicting garments in 3-dimensional space are being developed; computer-based fabric evaluation and inspection systems are now available; automated spreading technologies are more common; and laser cutters able to continuously cut single lays of fabric look set to make a major impact.

Because of the advantages derived from the use of already existing pre-assembly automation, these systems are rapidly becoming an essential technology for firms in many segments of the clothing industry in developed countries if they wish to remain competitive in domestic markets. One measure of this is a US government estimate that more than half of the annual 3%

productivity improvement registered by the country's clothing industry during the 1980s has been due to the use of automation technology in the pre-assembly stage.

b. Trade relocation rather than trade reversal

Even though they have had only limited effects on unit assembly costs, the increasingly widespread use of these techniques is beginning to have an impact on North-South trading patterns. This is occurring not via trade reversal but due to trade "relocation" from one region of the Third World to another. Growing market pressures on retailers to provide greater product variety are playing into the new competitive strengths of Northern users of pre-assembly automation.

As shall be discussed further in the next section, retailers are pushing suppliers to offer a rapid turnaround on reorders. The use of CAD systems and CNC cutters gives this responsiveness at the pre-assembly stage - reorders can be graded, marked and cut in a matter of hours. However, long assembly times and even longer transit times still pose a problem. In order to reduce turnaround times in the assembly stages, domestic producers who previously might have sent pre-cut pieces for assembly to Asia are now turning for offshore assembly to the Caribbean and Mexico in the case of the US and the low-wage countries of southern Europe, the Mediterannean and North Africa in the case of Europe.

Wages in some of these countries may be higher than in Asian locations - but the economic advantages derived from the use of pre-assembly automation are proving sufficient to tip the balance in their favour. Figures are difficult to come by but some analysts estimate that pre-assembly automation has already accounted for a 5-10% shift in the US offshore assembly trade from Asia to the Caribbean countries. No comparable estimates exist for the scale of European trade relocation but it may even be higher. At any event, this technology-induced sourcing shift denotes the growing importance of geographical proximity as a new competitive advantage for some countries.

c. Incremental progress towards assembly automation

Unlike the pre-assembly phase, the application of microelectronics technology to sewing has proceeded at a much slower, more incremental pace. the basic changes introduced have been microelectronic-based control units added onto the sewing machine - but without any major redesign of the machine or of the principle of sewing two pieces of fabric together using a needle and thread.

Two sorts of applications have been developed. The first is the use of microprocessors and CNC units on expensive ($20-40,000) high volume, special purpose machines used for such tasks as belt-loop attachment and collar stitching. The second type of application has been the development of less costly ($2,500 - 7,500) more flexible operator-programmable machines used for a variety of tasks. This application allows the operator to "teach" the machine a sequence of operations that it then repeats automatically and at high speed.

In both cases, there are significant gains in machine productivity over conventional equipment via greater speeds (up to 60% faster) and more

accuracy. However, with conventional machines costing anywhere from $500 - $1,500 these applications are still only cost-effective in a limited range of tasks. Diffusion has been limited - at best in the US only the largest firms have as much as 20 per cent of their sewing machines equipped with microelectronics-based controls. The picture is a little different in Europe where generally higher wages and more progressive management has meant a greater degree of penetration in specific segments - particularly among the larger firms.5/

However, it is still the case that even with these innovations, the critical one machine/one operator link has not been broken. Nor has the universal automation of materials handling both between work stations and around the machine head yet been achieved. Therefore with a few important exceptions as discussed below, the central determinant of international competitive advantage in the clothing industry remains largely unchanged.

This shows up in the results of the few available studies that have sought to establish the degree of trade reversal and plant relocation from developing to developed countries that has occurred up to now. In relation to the US, some of this has already occurred in segments such as hosiery, jeans, shoes, men's shirts and children's clothes as documented in Hoffman and Rush (1988). Mody and Wheeler (1988) likewise point out that assembly automation-induced trade reversal has occurred to a somewhat greater extent in Europe because the higher wages there (20-30% above the US) have prompted greater investment in assembly automation thus making domestic firms more competitive with low cost imports.

However, these scattered examples of trade reversal are vastly overwhelmed by the clothing exports from the developing countries that have now reached approximately $20 billion annually. This finding has important implications for developing countries. Rather than facing the rapid erosion of competitive advantage in one of their most important export sectors, assembly automation at the moment is in fact a barely visible phenomenon. At least in terms of shifting trading patterns, assembly automation is unlikely to cause developing countries any signficiant worry in the short term.

There are however some important indicators of ongoing developments that suggest Third World clothing exporters cannot afford to be complacent or assume that the situation will never change with regard to automation in the sewing room. These indicators of potential change are briefly discussed below.

3. The growing possibility of radical technical change in the future

There are three factors at work which sugges that the scope and pace of assembly automation may increase substantially in the future.

a. Growing concentration

The first of these factors is a tendency towards greater concentration among clothing manufacturers, in the US as well as Europe. Though still low, concentration levels are beginning to move upward - a trend that has led to one estimate that by the end of the century, between 75 to 100 US manufacturers could account for 75% of total output.6/

This trend is significant. One of the major factors constraining the diffusion of assembly automation have been the very large numbers of small firms that dominate the industry in the OECD countries. These firms are risk averse, suffer serious capital constraints and operate at low levels of output - all factors that make them unwilling to make high investments in equipment that is still very expensive and inflexible relative to their requirements. However, as concentration increases, and large firms account for a growing share of total production in the sector, they should be more willing to invest the sizeable sums in R&D and equipment purchase that will be necessary to automate the sewing room.

b. More innovative capital goods suppliers

Suppliers of production equipment to the clothing industry have traditionally been basically mechanical engineering firms. Faced with industry demand for low cost, relatively unchanged technology, there has been little incentive for these firms to embark on major R&D programmes designed to make a breakthrough in automation technology.

However, the structure of capital goods supply is beginning to change character. New, electronics-based equipment suppliers have entered the sector. This is most notable in relation to pre-assembly where all the major suppliers of CAD and CNC technology are essentially electronics firms. The same sort of firm is beginning to take an active interest in assembly automation. At the same time, both the traditional equipment suppliers and large clothing producers have begun to target their R&D efforts on developing radical innovations in assembly technology. Together with the developments reviewed below, these forces represent an industry focus on assembly automation that has never existed before.

c. Public-sector supported initiatives in R&D

This resurgence in R&D aimed at assembly automation on the part of equipment suppliers and clothing producers is also linked to a major set of government financed R&D initiatives with the same target. These projects, taking place in the US, Japan, Sweden and the EEC are the most significant new element to be injected into the innovation process in the clothing sector for the last 50 years. All are focussing on cracking the assembly automation problem through the investment of substantial resources in R&D carried out on a collaborative basis with clothing manufacturers, equipment producers, automation specialists, etc. Below only the US and Japanese projects are reviewed in detail.

The US project is a joint initiative between the textile-clothing industry and the government known as the Textile & Clothing Technology Corporation (TC2). The objective of TC2 is to produce a system using computers and robots that could automatically load, fold and sew limp fabric into a finished garment. From 1981 to 1988 the government provided $3.5 million per year with industry and organized labour contributing another $5 million plus per year to the project currently being carried out at the Charles Stark Draper Laboratories of the Massachusetts Institute of Technology.

So far it is still far too early to judge the technical and commercial success of this initiative. On the technology side, a variety of prototype machines involving automated assembly of sleeves, coat backs and trousers and

the automatic pick-up and positioning of a single fabric ply have been developed and subcontracted to equipment manufacturers for further commercial development. At the same time, the deadlines for achieving some of the more ambitious technical goals have been postponed. Nevertheless the commercial results of TC2s work are eagerly awaited by the industry.

Beyond the R&D efforts, there have been other important spinoffs from TC2. In April 1988, a multi-million dollar demonstration project, was opened in Raleigh, North Carolina. Called the National Apparel Technology Centre, it is intended to be operated as a clothing factory producing products for sale but using all available conventional and leading edge systems. The aim is to stimulate the industry to invest in new technology and have the Centre serve as a training centre and as a focus for industry seminars and the forging of new co-operative alliances. The Centre's set of activities could well be TC2s most important contribution to bringing the clothing industry into the mainstream of the information technology revolution.

The Japanese project, sponsored by MITI, was planned with a longer-term perspective, greater funding and more industry co-operation than the US initiative. Established in 1983 with a 7-10 year timetable and $100 million of government and industry support, the Japanese Automated Sewing System project (involving 3 research institutes and 28 companies) covers the whole assembly process from design through cutting to sewing, pressing and finishing and retail.

Its objective is to cut manufacturing time by at least 50% by developing elements of a flexible manufacturing system (FMS) for pre-assembly, assembly and finishing. At the core of the assembly automation projects is the plan to carry out sewing in three dimensions, using a movable sewing head that works on garments draped over a dummy. The ultimate vision driving the Japanese approach is even more revolutionary - to develop a system in which a salesman in a clothing store would take a hologram of a customer's body, and digitally controlled machines would then tailor-make an article of clothing!

The commercial aim of the project is not solely or primarily to revitalize the Japanese apparel industry - but to develop commercially viable systems that can be sold worldwide. Prototypes are expected early in 1990 with full-scale commercial production of the equipment expected to start some time in the early 1990s.

Given their past record at targeting market niches and then developing and producing products to fill those niches, it seems clear that the Japanese are striving to be the first to produce a flexible manufacturing system for use in the clothing industry. On the basis of past performance in other sectors, one has to rate their chances of success as excellent - with dramatic consequences for the clothing industry as a whole.

At the same time, however, there are still major technical, structrual and attitudinal obstacles to be overcome by all of the private and public sector automation initiatives currently underway in the industrialized countries. These should not be underestimated for they have so far stymied assembly automation efforts. Thus there is a great deal of uncertainty still surrounding the question of when and with what effect the automation of the assembly room will arrive and what will be its implications in developing countries.

Nevertheless, a recent effort to construct an econometric model to show the likely effects on North-South competitive advantage of the widespread diffusion of fully automated assembly technology generated results that are worth mentioning briefly.[7] The model calculated full costs of production and shipping for a range of garments to the US (with and without tariffs) for one low-wage Asian country (China), one high-wage Asian country (Rep. of Korea), the US and one low-wage regional exporter (Jamaica) as well as for different production partnerships (cutting in a high wage country and assembly in the low wage partner) involving these countries. Different levels of technology were assumed ranging from fully automated assembly (future best-practice), semi-automation (current best practice) and manual.

For standard garments in all cases, China or joint US-Chinese production is least cost. When full automation is introduced, US production is at near parity with Chinese costs in most cases, with US-Jamaica producting coming a close second in costs but uncompetitive in terms of time with US full automation. NIC production is not competitive in most of the cases - losing out to either low wage competition from China, low wage/quick response competition from US/Jamaica or automated production from the US.

These results are provocative suggesting declining NIC competitiveness, the growing strength of China at the expense of other low-wage countries and renewed competitiveness for the US. Whether they will be borne out or not depends on many factors. Careful observation of the trends in technological change that might underpin these developments in the longer term is clearly called for. However, there are other forces at work in the indusry which deserve much more immediate attention and which have major implications for policy in the short run. They are dealt with in the next chapter.

IV. MARKET-DRIVEN RESTRUCTURING AND FLEXIBLE RESPONSE: THE NEW COMPETITIVE CONTEXT IN THE CLOTHING INDUSTRY

Though fully automated clothing production still lies some time in the future, the structure of the clothing industry in the OECD countries and its sourcing, manufacturing and retail strategies are moving in a direction that is fundamentally different from before. The essence of these changes is a shift from the mass production of standardized products, using narrowly skilled workers and dedicated, high volume technology, towards a mode of production that involves the manufacture of specialized products using a broadly skilled workforce and universal, multi-purpose machines.

Information technology is playing a part in this transformation but so are other factors. The most important of these is that shifts in the pattern of consumer demand are driving fundamental changes in the philosophy of manufacturing and supplier relations embraced by clothing retailers, clothing producers and extending through to textile firms.

Any strategy for clothing production in developoing countries must take these closely interconnected changes in markets, technology, structure and strategy as the starting point for policy formulation. More generally, valuable lessons can be drawn from the changes now underway in the OECD clothing industry that are of immediate relevance for the whole of manufacturing industry in developing countries. To grasp the essential

character of these developments, it is best to start with a brief review of changes in the market place and in the pattern of demand that gave initial impetus to the ongoing transformation of the clothing industry.

1. Changing market conditions

As consumer markets developed and expanded in the industrialized countries in the post war period, clothing manufacturers seeking to capitalize on the rapid growth in demand, gradually adopted the methods of mass production. A number of factors hindered these efforts such as the technical characteristics and economics of assembly (discussed above) and the natural segmentation that occurred in the market as a result of the varying clothing requirements of groups of final consumers separated by differences in age, sex, occupation and income level.

Although these constraints meant the clothing industry was not able to achieve scale economies commensurate with other assembly-intensive industries, a number of segments - e.g. menswear and workwear, hosiery and household linen - did lend themselves naturally to long runs of standardized products. And even in those segments where fashion played a bigger role and required shorter runs, there were nevertheless substantial pressures placed by retailers on manufacturers to strive for the longest runs possible of relatively standardized products in order to provide the lowest unit prices.

These large multi-store retailers - Marks and Spencer in the UK, C&A in Europe, Sears and K-Mart in the US - were able to do this because they dominated the distribution networks and retail outlets and were thus able, to an extent, to divide the market into stable segments for which they could set the pace and direction of fashion change and in turn dictate their requirements to suppliers.

This "market-induced" concentration on price competition based on high-volume production of slowly changing products left domestic clothing producers in OECD countries vulnerable on two fronts. First, they became highly dependent on the sourcing decisions of the large retailers. Unfortunately for the clothing manufacturer, these volume retailers were primarily interested in securing supplies at lowest cost and they were quite willing to quickly go elsewhere if domestic firms could not meet their price.

Second, the competitiveness of the domestic manufacturers was wide open to attack from low-wage suppliers in developing countries, who during the 1970s were able to master the skills and technology associated with producing long runs of standard products. It was therefore almost inevitable that the ceaseless search by retailers for lowest cost sources would create opportunities whereby developing country exporters were able to make the sort of massive inroads into market share of OECD procedures that was documented in chapter I.

In the early 1980s, a new set of market conditions have decisively changed the determinants of competition in the OECD clothing industry. It has now emerged that there has been a basic transition in the demographic structure of the population of the advanced countries towards one that encompasses a larger proportion of higher income, and therefore more discerning consumers. This change has been accompanied by a major and rapid shift in consumer taste towards a preference for individual choice, constant variation and higher style content in clothing purchases.

Collectively these changes have fragmented the mass market, forcing retailers to target precisely specified segments of the market by offering a wider variety of more highly styled and more rapidly changing products. Firms operating in the upper-middle segments of ladies clothing such as NEXT in the UK, Benneton from Italy (but now all over the OECD) and the Gap in the US have been in the forefront of a new breed of retailers who have perfected this new marketing strategy. And because of their enormous success, the large, multiple retailers are being forced to move away from their previous commitment to the mass supply of slowly changing product lines towards marketing strategies that incorporate tactics similar to those of the smaller retailers.

2. Changing buyer-supplier relations

These market-driven changes in retailer marketing strategies are having profound implications for buyer-seller relationships throughout the whole of the textile-garment chain. Industry leaders are beginning to realize that the responsiveness and competitiveness of the textile-clothing complex can be strengthened significantly by closer links within the industry between the major actors. The implications of this realization are becoming apparent in the actions of the industry in a variety of ways - almost all of which have relevance for developing countries. Firstly, the design relationship has altered substantially. Whereas before, individual items of clothing were designed either by the retailer or the manufacturer in isolation from each other, there is now a growing trend for a much greater degree of consultation between these groups during the design phase. First, design teams from the retailers and from the suppliers will work together on fabric, colour and pattern selection and on the progressive development of the range of clothes to be offered. Thus in an increasing number of market/product segments, a new co-operative relationship in the design phase is emerging between retailers, clothing manufacturers and textile firms in the OECD countries that never before existed.

Second, a new element of stability and trust is being introduced into the contractual relationships between buyers and sellers. Previously, when price was the main determinant of sourcing, an antagonistic arms-length relationship existed at all levels - retailers forced prices down by playing off one manufacturer against another and by offering only short-term contracts; clothing firms in turn adopted the same strategy towards textile firms; with textile firms doing the same thing to fibre suppliers. Little trust and great uncertainty characterized these relationships.

Now the different types of firms involved are beginning to search for ways to remove the sources of this instability and mistrust. This is translating into a situation where buyers are willing to deal with fewer suppliers over a longer term; they are willing to exchange technical advice and assistance; financial commitments are being informally and sometimes formally extended to cover cloth purchases and clothing orders; contracts are beginning to be awarded based on quality, ability to change at short notice and reliability of delivery rather than on price grounds alone. Price is still important but there is now an assumption that by creating a degree of contractual stability between producers and users, producers will be able to better improve efficiency and thereby reduce costs that can in turn be passed on to the retailer.8/

A third, and perhaps the most important feature of the new relationships is that in return for contractual stability and co-operation, the buyers - particularly the retailers - expect their suppliers to be willing to offer a greater variety of product lines, and most significantly, they must be able to switch production between styles rapidly in response to short-term trends. As a result, lead times for the supply of products right across the board in clothing industry have become much shorter than was ever thought possible before - from an average of 15 to 22 weeks in the US and Europe to between 2 and 8 weeks respectively.

Retailers will now only finalize a portion of their order (30-70% on average now) at the beginning of the season and place additional orders as sales data indicate which lines are selling the best;increasingly, retailers will "book" production time with manufacturers and allocate it among styles as the season progresses. Within this there is an additional trend towards more and shorter fashion seasons increasing in number from two or three to 6 to 10 per year.

Finally, the increase in product variety and in the number of seasons and the reduction in lead times have inevitably meant that production runs have become much shorter. Whereas before orders would only need to be produced in the thousands of dozens, now the order can be for as few as 50 to 100 dozen, with specialist retailers averaging only between 1,000 to 3,000 units per style.

While it is difficult to judge just how far those new relationships between buyers and suppliers have spread in the OECD clothing industry, there is no doubt that industry leaders are aggressively pursuing these strategies. In the UK for example, NEXT, Marks and Spencer, Woolworths, C&A and Richard Shops have, to various degrees, introduced these changes into all of their supplier relationships. In the US, big retailers such as Wal-Marts and K-Mart, manufacturers such as Levi Strauss, Kellwood and Lee and textile firms such as Greenwood and Milliken have adopted a similar tactic. Given the leadership being shown by these large and very visible firms, experience suggests that in time, these new buyer-supplier relationships will be a general feature of industry structure in OECD countries.

3. Changes in production organization and in the technology of organization

From the producers' perspective, these changes in market demand and in buyer-supplier relations, have begun to erode substantially the economic advantages of long-run garment (and textile) manufacture by shifting the focus of competition from price as the prime determinant of competitiveness to variety, style, flexibility and rapid response. Not surprisingly, the new conditions therefore have had major implications for the way manufacturers organize their production and for the technology they use to control and monitor the production process.

Since the option of full assembly automation is not available, clothing manufacturers in particular have begun to discover that a critical source of enhanced flexibility of production could lie in the redeployment and retraining of their assembly workforce, and in a basic reorganization of their production line. Previous approaches to work organization in clothing (as in all assembly-based industries) emphasized task subdivision and worker specialization to produce large lots at lowest cost. However, as runs have

become shorter and style changes more frequent, clothing manufactures have begun to adopt a completely different philosophy.

Machinists are being initially trained (and then continuously upgraded) to be proficient in a wide variety of tasks including not only different types of sewing activity but also maintenance and repair, workplace "housekeeping" and quality control. In addition, lot sizes are being progressively reduced via elimination of the "bundle" system (which required an operator to perform the same task on a large number of workpieces contained in the bundle). The aim here is to strive for reduced in-plant inventories and allowing work to be produced and delivered on a "just-in-time" basis.

Machinery location, the pattern of workflow and the organization of workers is being recast according to unit flow, "group" technology and "quality circle" principles. This means small lots of garments are assembled from start to finish by small groups of workers who also have responsibility for quality control, for making suggestions to improve efficiency and for planning their work schedule.

Payment and incentive structures are being altered as well. Whereas before uniform piece rates were the norm, now the pay scales for individual workers go up as they acquire additional skills through in-house training. At the same time, the basis for calculating payment is shifting from the piece-work performance of the individual to the completed product performance of the group.

Finally, some companies have sought to completely overhaul their management-workforce relations on the assumption that many problems arise because of management mistakes rather than because the labour force is not working hard enough.[9/] This is the most difficult of all problems to tackle because it requires a degree of openness and honesty and willingness to admit mistakes on the part of people that is not normally found in the workplace. Yet in one US firm where this approach was adopted, quality improved by an order of magnitude, savings related to efficiency improvements were between five and ten per cent of sales, and absenteeism and employee turnover virtually disappeared as a problem.[10/] Admittedly, the large majority of OECD clothing firms have not yet begun to alter their approach to production organization nearly as far as the above suggests. There is little doubt, however, that these changes in work practices and production organization in OECD clothing firms are occurring and that the rate and scope of change will increase and expand in the future. And as will be discussed below, and in the next section, the implications for developing countries of the organizational transformation of the OECD clothing industry could be much more important than any technological developments that have occurred so far or are likely to happen in the near future.

4. Technological change in support of organizational change

Organizational change is not the only way that manufacturers are enhancing flexibility. Information technology is playing a major role as well at three levels within clothing manufacturing. The first has already been mentioned - the use of CAD and CNC systems in the pre-assembly stage increases flexibility signficantly because of the ability of these systems to very quickly accommodate changes in design parameters.

Second, within the assembly stage, a reorganization of the production line from batch to flow principles is emerging. Linked computer-based materials transport systems known generically as unit production systems (UPS) have begun to attract a great deal of attention. Work flow and component movement between work stations can be optimized and directed centrally while garments are moved automatically from station to station by means of a computer-directed overhead delivery system linked to workstations linked to terminals that can also monitor operator performance.

The advantages offered by such a system are much greater flexibility, reduced inventories, less handling time and greater control. There are regular reports in the industry press that the institution of UPS has among other benefits allowed firms to cut production times for individual garments from weeks to days and slashed 40-70 % off work-in-progress inventory figures.

UPS systems do have problems, however, in terms of having enough flexibility to meet the needs of the, particularly small, manufacturer while they are still quite expensive on a workstation basis ($3,900 - $4,500). This will restrict their use to large firms - but they could nevertheless spread rapidly among these in the future as the technical problems are overcome and as unit costs come down.[11/]

Finally, electronic communication within the firm, particularly in the assembly stage, and between firms is rapidly emerging as the technological heart of the clothing manufacturer's new rapid response capacity. Increasingly sophisticated, yet lower cost computer-based management information systems are beginning to diffuse rapidly through the clothing industry in developed countries.

For larger firms either using CAD systems in pre-assembly or already having central computer facilities, these can now be used to estimate costing as well as do cut-order planning and production scheduling. At the smaller scale end and where most firms operate, cheap micro-computers are being equipped with software and peripherals that carry out many tasks previously done manually such as the preparation of work dockets, stock control and fabric sourcing sheets.

Perhaps the most far reaching innovations are occurring in the area of computer-based production control systems (such as MRP II or its variants) that allow "real-time" monitoring of work-in-progress on a continuous basis and assist in production planning, line balancing and work measurement. One of the largest UK producers, Courtaulds, have introduced these techniques into 24 out of 40 companies and in one division producing nightware, sales have risen by 50%, "seconds" have been cut to 1% and raw materials stocks have been reduced by 30%.

These systems have begun to come down in price substantially and along the way have started to accumulate a positive "track record" in terms of cost-effective results. This trend is bringing these systems more within the reach of small firms. Provided their initial reluctance can be overcome, small firms, constrained by limited managerial resources, should find that these sytems will prove a great help in reducing unit costs, improving flexibility and shortening lead time.

The same technology also allows electronic communication between firms thereby facilitating much greater buyer-supplier responsiveness. The American

textile firm, Greenwood is hooked up by computer to its fibre suppliers, so that it knows when the truck leaves the plant, what it contains and where it is headed. As a result, its fibre inventories have been cut from three weeks to 2 days; the firm has done the same with its customers for denim fabric thereby cutting their inventories from 4 weeks to 3 days in one case and in the case of another large customer allowing warehouses to be done away with entirely.

When linked up to electronic point of sale systems (EPOS) at the retail end, in-house computer links with manufacturers allow instant communication of production, product and delivery requirements. The now classic and oft-cited example of this is the way the Italian clothing firm, Benneton operates. Each of its 3,200 shops worldwide is linked with EPOS terminals into a central computer which transmits detailed sales information to headquarters allowing rapid analysis of sales trends. Production scheduling from its own factories and 200 subcontractors is therefore tied directly to actual orders from the shops with deliveries facilitated in Italy and the US by a fully automated warehousing system. The success of this approach has virtually compelled other firms to pursue the same strategy.

The end results of these moves by the OECD industry to link new forms of inter-firm technological and contractural relations with intra-firm organizational and technological change are impressive, especially when considered from the perspective of the textile-garment-retail complex as a whole. Numerous documented examples can now be cited that show substantial increases in sales, greatly improved reliability of supply and significant cost savings from inventory reductions and efficiency gains right down the whole chain of sale and production.12/

Where these gains are coming from is just as important as the size of the benefits being derived. Up to 83% of a garment's life cycle, from raw material order to final sale, is spent in inventory rather than in production. Thus, a large share of the final price is accounted for by inventory "carrying" costs. It is precisely in this area, where these changes are having an impact. Industry estimates are that anywhere between 15-40% of the retail price for domestically produced garments could be eliminated by the widespread adoption of these new organizational and technological innovations.

Price reductions of this kind could bring OECD producers into a much stronger competitive position vis-à-vis developing country exports in a wide range of products where they simply are not competitive now. Of course, there are many structural, economic and psychological obstacles to change in this industry - witness the slow diffusion of even low cost, incremental sewing machine innovations through the industry.

But at the same time it needs to be remembered that the techniques being discussed above - apart from the sophisticated computer-based materials handling and communication system - are much less costly and risky to introduce than say a CAD system or a CNC cutter. Yet the potential gains to the successful adopter are potentially as great if not greater than those arising from the use of pre-assembly automation and existing assembly automation technology.

5. Industry level gains from organizational and technological innovation

The preceeding discussion suggests that these organizational and communications technology innovations may well diffuse very rapidly once a "threshold of awareness" about the net gains from their adoption is reached within the industry. There are some observers who claim that this is already beginning to happen in the UK clothing industry which next to the US had the highest overall rate of import penetration from developing country products of some 35% by 1981.

Individual examples abound - for example, Claremont, a large supplier to Marks and Spencers, has seen a regeneration in its fortunes and profitability due to a combination of the introduction of the new production methods and pre-assembly automation. It is now able to finish a garment in eight hours compared to four weeks, it has the highest margins of all Marks and Spencers suppliers, and it has boosted its return on capital employed to over 50 per cent.

This sort of improvement at the level of individual firms has translated into a much improved trade performance. Import penetration has been reduced slightly and stabilized at 31.2% overall; while there has been a pronounced shift in the composition of imports away from developing countries towards Western Europe - the share of developing countries in UK imports fell from 45.7% in 1980 to 38.9% in 1985 while that of the EEC and Western Europe rose from 26.6% to 36.2%, with the imports concentrating at the upper end of the market where quality and design count for more than price alone.

These changes have not been confined to the UK. Countries such as Switzerland and Austria have also registered similar shifts in the composition of imports away from low-cost garments towards higher priced, higher style products. Italy, as is well known, has been at the forefront of OECD countries who have benefitted from these changes in market preference.

The Italian clothing industry is characterized by products with a high design content, extreme flexibility (Italian firms can deliver garments in under two weeks even at the busiest time of a season) and a unique industry structure that features both close links between retailers and small producers and an extensive degree of regional co-operation between small producers in areas such as fashion forecasting, market research and technological information.

The advantages offered by these structural features have catapulted Italy in the space of 10 years into the position of the world leader in textile and clothing exports. In 1987, the Italian industry registered a trade surplus of $10.2 billion, a remarkable feat considering that wage costs per direct employee (including social costs) are nearly twice those in the UK, four times those in Hong Kong and twenty times those in countries such as Sri Lanka.

6. The potential significance for developing countries of organizational innovation in the clothing industry

It would be tempting at this point to draw the conclusion that the diffusion of these new inter and intra-firm organizational practices will have a major, and possibly negative, impact on North-South trade in clothing. These changes undoubtedly represent a fundamental shift in the market

conditions confronting developing countries. The move away from long runs of standardized products to small runs of a wide variety of frequently changing products would appear to work against the traditional competitive advantage of most developing country exporters.[13/] The same is true of the trend towards greater design intensity and the retailers' growing demands for more rapid turnaround times and a high degree of flexibility in ordering.

Such an assumption would, however, be static in character and potentially misleading since it does not allow for the possibility of a competitive response by developing country exporters. Indeed, from our perspective, the true significance of these developments derives not from the potentially negative trade implications (of their adoption by OECD firms) but rather from the real possibility that developing country firms may be equally if not more able to benefit from the introduction of the new organizational practices than their competitors in the North - particularly the US.

To understand this perhaps surprisingly optimistic argument, a little background information is necessary. The clothing industry is by no means unique in terms of experiencing fundamental change in the way production is organized. The same inter- and intra-firm organizational innovations now being slowly introduced in the clothing industry in the North are, in fact, spreading rapidly throughout many other sectors in the OECD countries, having first been developed and cultivated in Japan during the 1960s and 1970s.[14/] Indeed it is now widely accepted that much of Japan's early international competitive success in sectors such as automobiles, motorcycles, consumer electronics, etc., can be attributed to the gains in quality, productivity and responsiveness that Japanese firms derived from the assiduous application of these new approaches to production, organization and management.[15/]

After an initial period of reluctance in the early 1980s (similar to the present situation in clothing), many firms in the US and Europe have no embarked on a "frenzy of adaptation" in order to introduce these organizational innovations. A recent review of what is now a large and rapidly expanding literature has identified examples of their introduction in well over 40 sectors in the US and Europe, ranging from automobiles and engineering products, through to consumer electroncis and other light assembly products to continuous process industries such as steel and petrochemicals. One respected industry analyst has recently claimed that as many as 75% of the Fortune 500 firms are currently introducing major programmes of organizational change both within their own plants and in relation to their supplier networks.[16/]

The reason for this rapid uptake of the new approaches is simply that the gains from their adoption considerably exceed the costs incurred. Indeed so significant are the advantages deriving from the successful introduction of the new practices that many OECD firms have begun to feel that their competitive success in the future will depend just as much on their ability to introduce organizational change as on their ability to apply automation technologies.[17]

These new developments raise a very important issue for developing countries. If, as appears to be the case, the new modes of production, organization and inter-firm relations are widely applicable across sectors and countries in the North, might they not also be applicable in developing countries as well, not only in clothing industries but across the

manufacturing sector? If so, the positive advantages accruing to successful adoption in the South would be considerable. This is the question addressed in the final section, along with a consideration of the policy implications of the current and future patterns of technological and market change in the clothing industry.

V. CONCLUSIONS AND POLICY IMPLICATIONS

The changes in technology, markets and industry organization that are taking place in the OECD countries indicate that developing countries are now confronted by a profoundly different competitive context in the textile-clothing market from what existed in earlier periods. In the 1960s and 1970s, these countries sought to establish and nurture export-oriented fabric and clothing production so that they could take advantage of their inherent low-wage competitive advantages in an industry where entry into production was low cost and markets were relatively open.

In the 1970s, because of rapid Third World export growth, the developed coutries were forced first into a defensive, protectionist position and subsequently had to resort to draconian restructuring measures to survive. Since then they have been striving to re-establish their competitiveness through technological innovation and demand-driven marketing and sourcing strategies.

In textiles this competitive response has been very successful - in many industrialized countries, highly efficient, versatile and very capital-intensive producers are now in a position to resist any further major inroads on their market share from low-wage suppliers. As a result, developing country producers - both estbalished and new entrants - have no choice but to undertake major modernization and technological upgrading efforts in the textile sector simply to retain their current position in the world market and prevent loss of market share.

In the clothing industry, the competitive response of the North to low-wage competition from developing countries is just now beginning to reshape the determinants of international success in their favour. This somewhat delayed recasting of the OECD clothing industry and market provides developing countries with an opportunity to mount a competitive response of their own - something they were largely unable to do in the case of textiles. However, the rate at which restructuring is taking place internationally does not permit any complacency on the part of developing countries. Rather it makes it imperative that they, in turn, develop strategies to counter the new forms of high-wage competition that are now emanating from the clothing industry in the North.

Clearly, in this altered international context, conventional strategies for developing and expanding an export-oriented clothing industry will grow less relevant over time. Production of clothing is no longer the logical first step in export-oriented industrialization. The simple fact is that throughout the global clothing sector, demand has contracted, market access is much more difficult and the rates of return are now much lower for inexpensive, simply styled garments produced in long runs by unskilled workers - precisely the type of clothing products where most of new entrant Third World clothing manufacturers have been successful in the past.

What is required now are government policies and firm strategies that take full account of the new context and the emerging determinants of competitiveness so that their existing positions can be strengthened and lost advantages can be reclaimed. These strategies will undoubtedly differ according to the current status and capabilities of the clothing export sector in different countries, particularly with regard to the growing importance of geographical proximity as a determinant of advantage in the marketplace.

Moreover, the new conditions are being shaped not just by the technology element but by a range of non-technology factors most of which were not even considered important components of the international competetive equation in clothing 5 years ago. Any strategies and responses therefore have to take as much if not more account of these other factors in the short run as they do of the potential problems posed by automation technology - even though, as argued in Chapter III, the technology factor could become a much more important variable in the trade equation towards the end of the next decade.

Because the primary focus of this paper is on technology issues, this concluding section first discusses the policy implications of the technological developments reviewed earlier. It then goes on to discuss the wider range of policy issues arising from the discussion in Chapter IV.

1. Monitoring and managing the technological window of opportunity

By far the most important policy implication of the trends reported in this paper is that there does not appear to be any imminent danger of a technology-induced shift in competitive advantage and North-South trade reversal in the clothing industry. This means that the industry and policy makers in developing countries can largely concentrate their efforts on responding to the many other changes in the competitive context that are in fact taking place in the international clothing industry.

Clearly, however, developments relating to the pace and scope of technological change must be monitored closely. In the area of assembly technology, the various assembly automation R&D projects now underway in Japan, the US, the EEC and elsewhere must be kept under closer observation. The economic and technical characteristics and eventual pattern of diffusion of any system commercialized as a result of these projects must be studied and documented. It is simply too early to speculate on the competitive efforts and policy implications of these developments - the best strategy at this point is to remain well-informed and in touch with what is going on.

In relation to the diffusion and impacts of currently available stand-alone applications of CAD and CNC technology in the pre-assembly stage and the use of dedicated and programmable automated sewing machines, monitoring must also be a central element of any strategy. It has been shown above that there is evidence of a slight technology-induced pattern of either trade reversal or trade relocation due to the diffusion of these technologies.

Product segments in which this is or might be occurring need to be identified since it is conceivable that the trends could develop into a larger scale phenomenon in some important segments characterized by long runs and standard products - e.g. men's shirts and workwear. Countries whose exports are being or could be injured by this movement need to assess what, if any, responses are called for in order to overcome these trends - improving efficiency, upgrading quality, greater incentives or perhaps switching

productive resources into another clothing product segment where their advantages remain intact.

In the case of the NICs who appear to be losing ground to low-wage countries both because of quotas and because of technology, these trade shifts raise the question of these countries pulling out of the sector altogether - something which they have so far been reticent to do; or suggests at the very least the need for a willingness to subcontract a far greater share of their production (than they do now) to lower cost countries, thereby benefitting all parties involved.

Those countries who are benefitting from the shifts - (for example the Caribbean and North African countries) need to take steps to consolidate their position and further increase their attractiveness as off-shore sourcing locations - by enhancing the incentives offered, by also improving efficiency and quality, as well as upgrading communications and transport facilities, ensuring raw materials supplies, etc.

However, in a slowly growing market characterized by oversupply of standard products, fierce competition between low-wage producers within different regions of the Third World is likely to increasingly characterize trade in clothing, with the main beneficiaries being the retailers in the developed countries. This appears to be an unavoidable dimension of the emerging situation.

The question of the use of microelectronics-based clothing innovations by developing countries as part of these strategies is also a relevant policy concern. Perhaps the most important point to be made here derives from the discussion in Chapter IV. All countries are likely to gain far greater competitive benefits by first sytematically exploring ways to improve efficiency and quality on the basis of established productive capacities and already available conventional technologies rather than seeking any solutions in automation.

With some exceptions related to the NICs, there is no technological imperative at work in the clothing industry dictating developing countries must use computer technology to remain competitive. The economics of low unit-wage costs will clearly not work out in favour of expensive automation in most cases. More importantly, it has become clear now that unless major changes are made in the way production is organized at the firm level, firms are unlikely to be effective users of automation technology. This is going to be even more true in developing countries than it is in developed countries.[18/]

Obviously there will be cases where circumstances make the use of more automation justifiable - some of the larger NIC producers are finding it economical to use more automated sewing machines for some products. Equally, there are grounds for arguing developing country producers should explore the use of CAD systems both because of the gains in terms of fabric saving, as well as the greater flexibility offered by this technology. Again some of the Asian NICs do appear to be increasing their use of this technology - with government support.

Having a CAD capability compatible with their Northern customers may be one way that countries in a geographically favourable position can further enhance their competitiveness. Moreover, as CAD will play such an important

role in future, more automated, clothing systems, there are many "learning" benefits that could be derived by manufacturers if they had regular access to a CAD system but did not have to bear the costs and risks of purchasing an individual system. This could be organized through the establishment of a sectoral support institution - a policy initiative discussed in more detail below.

Overall, the NICs are undoubtedly faced with the hardest choices on the technology front since they are pressured on the one side by the OECD producers benefitting from advancing automation and still able to hide behind protective tariffs, and on the other by least-cost producers. As a result, if they wish to remain strong clothing producers, the NICs, particularly those with small domestic markets, need to move up the technology ladder in the same incremental fashion that the North is now doing.

This challenge already seems to have been recognized in countries such as the Republic of Korea, where the government is taking a very active role in bringing about the modernization of the clothing industry through a battery of fiscal measures encouraging investment in new technology and through the joint support with industry of sector-specific institutions that act as focal point for policy implementation, information collection, new product development, training and the provision of technical services.19/

For other countries, the need as well as the justification for investing in the latest in technology is much less. Of course, government policy must ensure that domestic clothing producers are aware of and have incentives to invest in the level and type of technology that is "appropriate" to prevailing factor costs and their own absorptive capacitities. Almost certainly, many producers in these countries will be using technology well below industry standard - this is as true in the developed countries as it is in the Third World.

The low wage advantage enjoyed by developing countries still provides them with a position at the "starting line" in the competitive pursuit for export markets, particularly in the OECD countries. But under the new conditions of competition, it is clear that low wages will no longer guarantee who is going to win the race. Winners and losers are now increasingly much more likely to be determined by their relative success in mastering the non-wage and non-technology determinants of competitiveness discussed in Chapter IV.

The changes in market preference in all categories of clothing towards higher style, more variety and more seasons, combined with the restructuring and strategic responses of the Northern clothing producers towards greater flexibility, closer buyer-supplier relationships and intra-firm organizational innovation suggest three related areas where new policy initiatives are likely to be required. These are discussed in turn below.

2. New approaches to industry strategy and industry surveys

The first set of measures - the need to carry out a comprehensive industry survey and to draw up an industry strategy - is perhaps a fairly obvious starting point about which, however, some less obvious points can be made. Regular industry surveys which collect standard economic data on firm size, output, employment, investment, productivity, profitability, etc., are, or should be, an essential precondition for effective policy making.

In the past, however, in many countries, such surveys were carried out perfunctorily, on an ad-hoc basis and with only partial coverage. Government policies for the sector were often equally superficial, with the government's main policy concern usually being to secure the maximum degree of trade concessions from the importing countries and then to allocate these among local producers. Competitiveness on the part of the local industry was automatically assumed.

As has been argued above, this assumption is no longer valid and the change in perspective this implies needs to be reflected in a government's approach to sectoral development and support. This is necessary in all countries but is particularly critical in the many poorer economies where the sector is a major employer and where clothing exports account for a large share of current and planned manufacturing sector foreign exchange earnings. Strategic planning in relation to the short- and long-term development of this sector is now a necessity. OECD governments and clothing firms are investing considerable resources in information generation activities to support their strategic planning efforts precisely because conditions are changing rapidly and new perspectives are called for. Developing countries need to do the same if they want to stay in the game.

a. Instilling an international perspective

The process of change in approach needs to begin with the content and objective of industry surveys. The first step is to ensure that policy makers possess a clear understanding of current and future trends in all relevant areas. This means that a first priority must be a review of relevant international trends in demand, fashion, purchasing, protection, technology, quality, delivery times, buyer-supplier relations etc.

This information needs to be collected at the level of specific product categories as conditions and determinants of competitiveness differ markedly between categories. Most importantly the coverage of this must include existing OECD and potential regional markets. The need to focus on regional markets is obvious for countries with an in-built geographical advantage. They are now in a better position than ever before to exploit their proximity in time and space.

For those countries more distant from the traditional markets of the US and Northern Europe, the focus of international survey efforts must incorporate the relevant rapidly growing regional developing country markets - the high income Asian or Latin American countries, countries in the Middle East, as well as low income Europe and other niche market countries such as relatively high income island economies such as Cyprus, Greece, the Seychelles, etc. Market diversification will be critical in years to come - to assume that traditional markets will always be accessible or allow manufacturers to operate under that assumption is the same as condemning the industry to gradual disintegration.

b. Assessing the domestic industry

The knowledge generated by international surveys can then be used to guide the collection of information on the national industry. An important component of this national survey will be a review of domestic market conditions both in terms of pattern of demand as well as the degree of openness and competition faced by local manufacturers.

Typically domestic markets are largely closed to foreign competition in developing countries. Yet some movement towards greater openness will almost certainly benefit both the consumer and domestic manufacturers. Attention to expanding local market share in the face of competition is one of the best ways, manufacturers can hone the skills needed for export success. Moreover, a local "style" may also be a source of inspiration for designers to develop a national "look" that could be successfully marketed internationally.

Beyond this focus on the local market, a national survey of manufacturers will, in addition to the usual economic data categories mentioned above, need to give particular attention to collecting data and gaining knowledge in the following areas so that the response capacities of firms to the new conditions can be judged:

- firm product and marketing strategies;
- firm sources of knowledge and information;
- distribution of firms (by size) across product categories;
- nature of customers and their previous purchasing patterns;
- raw material availability and fabric finishing capabilities;
- firm performance in lot size, delivery and lead times;
- factory layouts, stock levels and work-in-progress inventories;
- management structure, capabilities and perspectives;
- numbers, quality and pattern of deployment of designers;
- educational and skill level of managers, technicians and workers;
- transport and communication availability and requirements;
- sector wide availability of specialist sources of know-how.

c) Stragegy formulation and firm involvement

With these two bodies of knowledge available, a sectoral strategy can be generated. The components and objectives of this will vary - but critically it needs to be formulated in light of relevant international trends and a comparative assessment of national industry performance against international standards. Some general points on these issues are made below.

First, our review suggests two elements will need to be present in most country strategies. The first is the upgrading of the design intensity and demand responsiveness of the product mix and marketing strategies of individual firms and of the sector as a whole. The second is the continual improvement of efficiency, reliability and flexibility so that long-term relationships can be built up with foreign retailers and suppliers to replace the unstable, short-term, price-dependent links that now dominate.

The relative weight given to each will vary between countries and product segments. Ultimately, however, both elements must converge - demonstrable productive efficiency and flexibility are necessary for unknown manufacturers to break into new markets and consolidate their position in established markets while improved design content and greater market responsiveness are necessary to allow expansion once the foothold is secured. Points of policy relevance following form each of these elements are explored below.

Second, as should be obvious, the policy making process cannot be carried out in isolation either from the reality of international trends or from the reality of domestic constraints operating on local industry and on the government's ability to deliver the policy measures called for. One dimension

of this awareness is the need to recognize that the days of pervasive government involvement in all aspects of industrial development seem to be coming to an end. This is as true in clothing as is in any other sector.

Hence the success of any strategy for strengthening the clothing industry is going to depend partly on the government's ability to bring sector specific expertise to bear on the problem, as well as on the willingness of the producers themselves to support the policy proposals put forward by the state. The best way to achieve the latter aim is to ensure that the industry is fully involved in all policy stages - initial data collection and analysis, strategy formulation and, if possible, implementation as well.

This is likely to be quite a new departure for most governments, and one difficult to manage since it implies a diminuation of control and responsibility for middle-level policy makers. However, a way forward must be found through the protective bureauctratic malaise characteristic of many government departments (in developed as well as developing countries). The experience of other countries suggests that a good mechanism for enhancing the effectiveness of the type of sector-specific government/industry initiatives called for by the new conditions is to channel these through some form of institutional framework for the provision of collective services. This is the next area of policy concern to be discussed.

3. Collective provision of services

As indicated above, one element of industry strategy must be to upgrade the design intensity and demand responsiveness of the product mix and marketing effort of export-oriented producers. To do this, detailed information is needed on current and prospective fashion trends, design forecasts and good research on the characteristics of different markets. Generating this information is an expensive and time consuming proposition far beyond the capacities of the many small firms making up the clothing industry in developing countries. Yet to actually acquire and interpret this knowledge requires sector specific expertise generally not available within governments.

This sort of problem illustrates why the fragmented nature of the clothing industry in most developing countries, and the small average size of firms is typically seen as an obstacle to progress. Yet one of the features of the new competitive conditions is the fact that a fragmented industry composed of small firms now appears to possess competitive advantage because of its inherently greater flexibility and responsiveness. This is a key characteristic of the highly successful Italian and Japanese clothing industries.

However, small firms do need organizational and technical support. Institutions to provide both of these have been fostered by the national and local government in Italy and Japan and this pattern of joint public-private co-operation suggests an innovative way forward for government policy in the clothing sector in developing countries.

In Italy, regional co-operatives composed of, some large but mainly, small firms (less than 50 employees) provide their members with a comprehensive range of professional services. These co-operatives were started up with regional and local government support but are now almost entirely self-financing on the basis of a small annual subscription fee ($600 average) paid for by each member.

The services provided by these co-operatives (with a staff size of 6-8 people) range from information services in the areas of design intelligence, market research and fabric sourcing to technical assistance in the area of (new and old) technology choice and adaptation as well as management training. They also act as a focum for organizing joint production and order distribution initiatives. In one instance, a regional co-operative was instrumental in setting up a computer network that was used to divide up incoming orders among the members which otherwise would have had to be turned down.[20]

Almost precisely the same form of industry/state supported co-operatives funcioning primarily to advance the fortunes of small firms exist in Japan and as yet on a much smaller scale in the US and UK.[21] Another aspect is that, again, in both Italy and Japan, large manufacturers (such as Benetton and Asahi Toray) perform very similar functions for their network of subcontractors.

There would appear to be considerable opportunities for governments to take the initiative in setting up similar clothing industry co-operatives in developing countries. Seed money for the start up could come from government and/or international agencies. But the service agencies would operate on a permanent basis only if the industry was prepared to provide both financial support and to be deeply involved in their actual day-to-day management and functioning.

The scope of tasks undertaken by these co-operatives could be quite wide ranging from provision of the knowledge-intensive, market-oriented services described above to a variety of other specialist activities derived from the specific need of developing country firms to respond to the new competitive conditions now facing them. Some of these activities could include:

- the carrying out of joint export marketing for local firms;
- the operation of a CAD bureau to service local firms and provide training on, and exposure to, this critical technology;
- the compilation of a register of local and international designers willing to work with domestic firms and/or to act as the focal point and conduit for the development of local design capabilities;
- the provision of advice and information on technology availability, costs and benefits and support for its introduction;
- the enforcement of agreed industry standards on quality, reliability and delivery;
- the focus for other industry initiatives in areas such as raw material acquisition and fabric finishing or the setting up of just-in-time supply relations between buyers and suppliers;
- the provision of centralized and/or in-house training facilities for management, technicians, supervisors and production workers;
- the provision of consultancy services for factory layout, design of incentive systems, organization of the delivery network, reoganization of the workforce into groups, etc.

Under each of these headings, specific policy initiatives would be called for some of which might be quite different frm the conventional approach because the thrust would be on providing services suitable for the new competitive conditions. An example might be the training offered. At one level, more training of all skill categories will certainly be necessary since the clothing industry is notoriously poor at providing sufficient training. However, it is the substance as well as the quantity of training that needs to be different. Managers have to be introduced to the new practices and operatives need to be equipped with broader skills.

Specifying the nature of the different policy initiatives and programmes called for would require care but would not be a difficult task. If necessary, a competent specialist advisor, knowledgeable in current internatonal trends, working with a national expert familiar with local conditions and equipped with a data base on the domestic industry organized along the lines described above could carry out the task of policy design according to the new parameters defining firm and industry strategies.

The problems, however, lie less with policy design than with effective implementation. Responsibility for different segments of industrial policy is usually shared among different government departments each with multi-sector and multi-task responsibility such as vocational training, export promotion and the provision of technical advice. Typically, none of these departments really have the resources or expertise to cope adequately, effectively and efficiently with specific industry needs - a particularly costly constraint at a time when firms need to respond to rapid and fundamental change.

The logic underlying collective service provision is that industry as well as government is centrally involved on a co-operative basis in the funding, design and operation of the proposed collective service institution thereby substantially increasing both the resources and the expertise that can be made available well beyond what is usually offered.

Indeed, it is possible also to envisage an industry-wide association that in fact takes on the responsibility for administering other government policies in the clothing sector including the design of an overall strategy, administering quotas, modernization of grants and tax-related incentive schemes, assessing new investment plans and generally presenting the industry case within government. While this may seem an ambitious objective, the Republic of Korea has established just such an institution to oversee the modernization of its textile industries.[22/]

Such an integrative insitution could eliminate the costly and frequently counterproductive duplication of responsibilities for clothing industry development referred to above. The economies of specialization inherent in collective service provision means that a much larger number of firms would have access to services designed to improve their competitiveness than with conventional initiatives. Member firms would therefore be direct beneficiaries of (and have an explicit interest in) its efficient and effective operation rather than being suspicious of a wholly-government financed agency staffed by non-experts. By bringing industry into the process, a much more coherent industrial structure can be created - one that is responsive to market conditions rather than dependent upon government fiat.

4. Pursuing new routes to productivity improvement and greater competitiveness

It was emphasized above that developing country clothing firms have to find a way of consistently improving their levels of efficiency if they wish to win and retain long-term relations with Northern retailers and manufactures. There is nothing new about such a recommendation. Indeed, it is virtually axiomatic that reports like this one place the need to improve firm level efficiency at or near the top of their policy recommendations. This emphasis on the paramount importance of improving productivity is entirely justified in relation to the clothing sector (as in many other industries) since there is often a gap of anywhere from 25-50% between productivity levels in the North and those in the South, even when the technology levels are roughly equivalent.

Typically, the measures called for relate both to the need to inrease the quantity and quality of training made available for managers, technicians and direct production workers; and the need to ensure that firms are managed according to best practice standards in the industry. Identifying what training measures are required and specifying ways to improve firm management is straightforward enough under normal conditions.

However, the discussion in Chapter IV has argued that in fact a new best-practice approach to production organization and the training of workers is beginning to surface in the clothing industry in the OECD some time after it started to sweep through other industrial sectors. Production lines are being reorganized along flow rather than batch principles; inventories and lot sizes are being reduced while varieties are increased; workers require new and broader skills to respond to the new demands of varied output and more flexible work organization; and incentive systems are having to be recast to take account of their higher skill levels and greater responsibility.

It has been shown that firm-level gains arising from the adoption of these new approaches are substantial and indeed their introduction is viewed as increasingly critical to the competitive success of Northern firms since they eliminate many of the advantages currently enjoyed by low-wage countries. This is true not only in clothing but in many sectors.

If management and production organization practices based on mass production methods are being abandoned by firms in the industrialized countries, what are the implications of this for industrial policy in the Third World - again, not just in clothing but across sectors? Can developing countries respond to these developments? Or are they trapped in the same sort of capital, scale and capability constraint that severly limits their prospects for effectively absorbing automation technology? These are among some of the most critical industrial policy questions that developing countries have had to face in the last decade - yet they revolve around issues and concepts which are still unfamiliar to most policy makers and industrialists in the Third World.

Can the new organizational practices be transferred to developing countries? There are many reasons to argue that it will be extremely difficult to introduce the new practices in developing countries. Clearly there will be major obstacles. All of the financial, economic and market-related problems that currently constrain efforts to raise productivity

and improve quality in the Third World will work against the introduction of new practices.

The most critical of these are likely to be skill constraints. The new practices are particularly demanding of managerial and engineering skills of which there are severe shortages in developing countries. Another is the distorting effect of poorly forthcoming and highly protected markets on incentives for firms to undertake any innovative efforts at all. This problem will be particularly pronounced where there is excessive state intervention in production. Many other constraints on adoption could be listed.

However, at the same time, the available evidence on the diffusion and impact of these practices suggests, a priori that the preconditions for their introduction might be much more favourable to developing countries than it might appear at first glance. There are a number of reasons for taking this position. First, there is no doubt that the techniques, concepts and principles of the new practices are transferable across countries. They have diffused from Japan to the very different production environments in the US and Europe suggesting that most of the new approaches are not culturally-specific to Japan as was feared initially.

Second and much more important, the wide sectoral range of successful adopters in the North indicate strongly that many of the new practices are neither scale nor sector nor product specific. The specific management and organizational techniques developed to facilitate quick change over, broader worker training, lot and inventory reduction, production line reorganization, etc., can be introduced into any type of firm regardless of its product or output level.

And, while it is true that the new practices have been developed under conditions of assembly complexity and large volume (as in the auto industry), it is widely acknowledged that many of the approaches are in fact much better suited to light assembly and smaller volumes of output - precisely the sort of conditions that exist in much of Third World industry.

Third, the knowledge required to understand what the techniques are and how they operate in practice is neither patented, restricted nor highly priced. This knowledge in fact is "codifiable" and highly accessible at low cost since by now many of the leading practitioners have written practical, "how-to-do-it" books that are intelligible to anyone with experience-based knowledge of industrial practice.

Fourth, the techniques do not require new investment in embodied technology (i.e. new plant and equipment) and in fact are best introduced in the context of standard small volume machinery typically found on the factory floor of most Third World firms. In fact, as mentioned in Chapter IV, it could be argued that unless some of these practices are introduced firms will not be able to reap the full benefits of new technology. Thus organizational change can be seen as a key precondition to successful technological change.

Fifth, and related, the costs of introducing the practices are likely to be very low since no new capital investment is called for and the techniques themselves can be introduced on a modular basis. Indeed, there is evidence to suggest the new techniques are capital saving since existing machinery is typically used far more efficiently and over a longer period than

conventionally. This greatly reduces the overall risk element associated with their introduction - whereas the risks and costs of investing in new technology are likely to be relatively high.

Finally, we are not totally in the realm of speculation when arguing the new practices can be introduced into developing countries. There is in fact a limited amount of, as yet anecdotal, evidence that suggests these practices are already being successfully introduced in some developing countries. According to (unpublished) information, the furthest advanced appear to be NIC subsidiaries of Japanese firms operating in the electronics sector, followed by the Mexican and Brazilian subsidiaries of TNC automobile and component firms based in the US and Europe.

Most surprisingly, some of the best examples of successful introduction in developing countries are to be found in the textile-clothing sector. One case involves a large (20,000 employees/20 factories) clothing producer in Brazil. Senior management in this firm, drawing on its knowledge of Japanese management techniques and group technology ideas has reorganized production in each of its plants precisely along the lines suggested by the new practices.

After the new system was introduced, work-in-progress inventory was eliminated completely after having previously accounted for 30-40% of product costs; the cycle time was reduced from weeks to hours; and productivity was increased by between 200-400% for different tasks.

In another case involving a textile firm in Venezuela, previously notorious for its low productivity and apalling labour relations, the firm introduced group technology practices and management adopted a more co-operative approach towards its workers offering higher pay for those willing to learn more skills. Productivity increased by 300% and the firm is now hailed as a model of mangement-worker co-operation.

Taken together, these points appear to constitute a powerful a priori argument that the new practices could be successfully introduced in developing countries not only in the clothing industry but across sectors. Indeed, it can even be argued that they could be introduced across a far wider range of countries and sectors than is the case for the new computer-based technologies which are suitable only for the most advanced developing countries. The new practices could well be applicable even in the poorer, smaller economies who are rendering ineffective most lines of conventional policy advice regarding the regeneration of industry.

REFERENCES

1. See UNIDO 1987. "Textile Policy Issues for Developing Countries" PPD/R.5, 20 August 1987.

2. See also Mlawa, H. (1983). The Acquisition of Technology, Technological Capability and Technical Change: A Study of the Textile Industry in Tanzania. Unpublished D. Phil. Thesis. Science Policy Research Unit, University of Sussex, Brighton, England.

3. This is because once the information defining the shape, style, components, etc. of a garment are digitized for use on the CAD system, this same information can, in theory, be used to direct the operation of equipment at every subsequent stage of production.

4. See Hoffman, Kurt and H. Rush. (1988). Microelectronics and Clothing: The Impact of Technical Change on a Global Industry. Praeger Publishers, New York and London; Marion Whitaker, (1988), "Technical Change in the British Clothing Industry", Mimeo Report, Centre for Business Research, Brighton Business School, Brighton Polytechnic, Brighton, England.

5. See Mody, Ashoka and David Wheeler (1989) "Emerging Patterns of International Competition in Selected Industrial Product Groups", Journal of Development Economics, Forthcoming, 1989.

6. See Hoffman and Rush, 1988.

7. See Mody and Wheeler, 1989.

8. As in so many other industries these days, the system devised by Japanese textile firms stands out as the best example of this approach. The keritsu system which throughout the manufacturing sector in Japan binds different segments of the industry together is very much in evidence in the textile-garments sector. Here the chain extends from the spinner who provides the yarn, to the cloth wholesaler or apparel manufacturer who buys the fabric, produces finished goods and sends them on to the retailer. In the early 1980s, only 20 per cent of Japan's cotton and cotton blend cloth was made by weavers who were free to buy yarn on the open market; at the other end, 75 per cent of small firms sell their fabric to a single purchaser; while most garment firms make 70 per cent of their fabric purchases from no more than three suppliers. The advantage is security - selling yarn cloth and garments on the open market might bring a slightly higher price but the keritsu ties ensure that the firm sells all that it can make.

9. For the best discussion of the problems that management faces when introducing the new practices, see Walton, Mary (1987), The Deming Management Method, Dodd, Mead & Company, New York.

10. See Walton, 1988.

11. One Japanese firm using UPS has already begun to produce individual garments on a made to order basis - and has plans to take individual orders specifying style, fabric and size by computer while at the same time issuing the customer with a guarantee that the garment will be delivered a few days later. See Roberts, C. Zeb (1986) "A UPS Appraisal for Quick Response", Bobbin, March 1986.

12. See for example Kurt Salmon Associates, Inc. (1986), "Quick Response to Retailing", The KSA Perspective, January 1986; Cotton, R.E. (1986). "QRs Bottom Line":, Apparel Industry Magazine July, 1986.

13. See Mody and Wheeler, 1989.

14. In the clothing industry literature, these techniques are commonly referred to as "Quick Response" technologies, while in the wider industrial policy, innovation and business school literature they are collectively grouped under headings such as Total Quality Control, Just-in-Time Inventory Control, Total Preventive Maintenance or more generally as Japanese production methods because many were originally developed and perfected in Japan.

15. For a thorough discussion of the automobile case where the Japanese organizational competitive advantages were first documented see Altshuler et al.,(1984) The Future of the Automobile, MIT Press. For other mainstream publications where these issues are discussed and the evidence reviewed see S. Cohen and J. Zysman. (1987), Manufacturing Matters: The Myth of the Post-Industrial Economy, Basic Books Inc., New York; M. Piore and C. Sabel (1984), The Second Industrial Divide, MIT Press, Boston; Schonberger, Richard J. (1987) World Class Manufacturing: The Lessons of Simplicity Applied, The Free Press, New York, N.Y. and David Garvin (1988). Managing Quality: The Strategic Competitive Edge, The Free Press, New York, N.Y.

16. For an extensive review of the literature and discussion of the whole area of organizational innovation and its relevance to developing countries see Hoffman, Kurt (1989). Technological and Organizational Change in the Engineering Industry. A study prepared for the Industry Division, World Bank, Washington D.C., to be released as a bank publication in 1989.

17. This is a view increasingly shared by policymakers in the industrialized countries as demon trated by this quote from an influential study recently prepared by the US National Research Council. "The changes in people and organizations will be a difficult aspect of the revolution in manufacturing. They require a dramatic operative sharing of responsibilities. Many enterprises need changes not only in broad organizational areas and management philosophy but also in employee behaviour, union policies and customer-supplier relations. Every stakeholder - managers, employers, owners, suppliers and customers - must recognize the challenge. The demands placed on manufacturers to be effective in an increasingly competitive marketplace can be expected to relentlessly push managers and workers in this direction". US National Academy of Sciences (1986) Towards a New Era in US Manufacturing: The Need for a National Vision. National Academy Press, Washington D.C. (pp. 51-52)

18. See Hoffman, 1989.

19. See the description in UNIDO, 1987.

20. See Office of Technology Assessment (1989) "The Impact of Technological Change in the US Fibre, Textile and Apparel Industry Complex", Unpublished mimeo, Washington, D.C.

21. See Office of Technology Assessment, 1989.

22. See the discussion in UNIDO, 1987.