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THE GARMENT INDUSTRY¹

The partial automation of the garment industry provides important insights into both North-South trading relations and gender relations in the work place². The garment industry is of major importance to Third World trade, especially to the NICs (Newly Industrialized Countries). Exports of clothing from these countries increased exponentially in the post-war period. The comparative cost argument for a global market, with each country producing what they can do cheapest, has supported such a trade pattern on the basis of cheap labour. But this assumption is being eroded by a number of factors, the chief of which is the application of microelectronics (accompanied by concentration in the OECD and a measure of protectionism).

The assembly of clothes requires a lot of manual manipulation because of the limp nature of the material. For over fifty years the technology has been based on dexterous workers and robust flexible sewing machines. By dexterous I mean having the sort of skill acquired by motor training, contrasted with skill which is knowledge based. This production technique allowed for the easy entry of small firms and resulted in high levels of competition. Even now, for instance, there are over a thousand garment firms in Montreal alone. Heather Menzies writes:

"Canada's textile and garment industry is the third-largest source of manufacturing employment. While it's a ghetto, it is also an employment niche, especially for immigrant women. But the niche is highly vulnerable to the technologies transforming the industry."³

From 1971 to 1988 employment actually increased in the Canadian Garment Industry⁴. But since that time decline has been steady. In specific product categories, over 50% of domestic consumption has come to be satisfied by imports, but the overall average is around 14%. Job losses in the industry have been severe in the USA and Canada (in the 10s of thousands), though this has been partly the result of automation as well as of increasing imports. These job losses seem mainly to have been in unionized labour. The ILGWU lost 10,000 members in Quebec in the period 1980-1990⁵. In Ontario, 42 unionized apparel factories closed between 1988 and 1993. However, the slack has been taken up by hundreds of small contractors using underground piece-workers, said to be mainly immigrant women⁶. Many of these are home workers who use their children for finishing, removing loose threads and packing.⁷ There is said to be a shortage of this underground labour which is presumably one important reason for the pressure by the Manufacturer's Association for increased immigration

quotas. Some manufacturers have made intensive efforts to keep their immigrant workers by paying a decent wage and introducing teamwork. Levi Strauss is an example.⁸

Flexible specialization

The introduction of microelectronics has offered domestic firms the hope that they can compete against cheap labour and the tariffs and quotas which will be a consequence of global trading agreements. This hope has, in fact, not been realized when the aggregate industry is considered. But certain strategies such as FS (flexible specialization) have been successful for individual firms. This strategy does not try to restore competition through mass production at any cost. Instead it offers a new fashion product that creates wants that the customer had not been aware of. This is one of the forms of "niche" marketing. For this strategy, computerization is not used to replace skilled workers but to increase their capabilities. Ideally, the numerically controlled sewing machines are not only operated by but also programmed by the workers.

Computerization has become a prevalent corporate response to free-trade related clothing import competition as deregulation and the drying up of subsidies to support a Canadian clothing industry. By the mid 1980s the E-ton sewing assembly line from Sweden had become fairly common in the Canadian Garment industry. It has more than fifty individually engineered re-programmable work stations with a monorail type line for moving materials from one station to the next, each one equipped with sensor controlled gates that cause the material to stop or to pass by, depending on the instructions keyed into the system.

At each work station the individual operator receives the garment off the monorail conveyor, feeds it through the sewing operation, and loads it back onto the conveyor unit with the other hand. At each work station the most sophisticated E-ton 2001 system incorporates a computer-monitoring device that can relay information on the operator's work both for materials management and for calculating wages.⁹

New marketing strategies can also create a niche. For example, Calgary-based Kids Only Clothing Club uses Tupperware-style home sales techniques both in Canada and overseas.¹⁰

A variant of FS is "mass customization". This consists of lowering costs by flexible manufacturing and tight inventory control, even zero inventory. An excellent example is a 16-store New York shoe chain that practises this manufacturing policy. When a customer comes in, his or her feet are measured by a machine that transmits the dimensions electronically to the factory. The shoes are custom-made in hours. No inventory, no guessing; shoes that are actually cheaper to produce are sold at custom prices.¹¹

FS systems are, however, the exception rather than the rule. Let us look at the normal garment factory.

Normal Garment Factory

The following four activities are head-office functions that proceed in parallel with the next three shop-floor activities.

- DESIGN (CAD)
- ORDERING MATERIALS (MIS)
- PRODUCT ENGINEERING (MIS)
- PRODUCTION SCHEDULE MONITORING (MIS)

I have placed in parenthesis the acronyms for the appropriate automation technique: Computer Aided Design, and Management Information Systems. The complexity of the process and the extremely rapid changes induced by fashion make this one of the most difficult business to manage and therefore the management information systems (MIS) are likely to be of considerable complexity. The last few years have seen a strong move to design-intensive products with a very rapid response to market demand. At Benetton, in Italy, the factory order system is directly linked to point-of sale data collection. A significant swing in colour preference is known within hours at the factory and finds a response in production scheduling.

PRE-ASSEMBLY

Inspection (laser sensors, colour, density)
 Sorting and storage of cloth
 Pattern making from design (CAD)
 Grading (CAD)
 Marking or Layout (CAD)
 Cutting (CAM)

The shop-floor activities are divided into pre-assembly, assembly and post-assembly phases. Whereas only incremental innovations have so far been the rule in the assembly phase, there has been a dramatic re-structuring of the pre-assembly phase where the innovations can be truly classed as radical.

The revolution in the garment industry took place as a result of the introduction of CAD\CAM techniques which had been developed in the metals industry (See Trajectory Transfer of Techniques). The technology is particularly well adapted to a fashion-controlled industry because it favours a multitude of short production runs. It is equally suitable for footwear. For example Terra Footwear at Grace Harbour Newfoundland has an automatic digital sewing machine invented in Israel receiving instructions from a computer monitor. Their Austrian CAD CAM system cost 750 000 \$. They are linked by computer to the designers at the Markham ON plant¹².

ASSEMBLY

Up to 100 sequential operations.
 NC Sewers
 Robotic handling
 Automated Transfer systems
 Function-specific machines

History

MODELS OF POWER

1. Benevolent technocrat (Saint Simon)
2. Self-interested elite (James Burnham)
3. Servant of power
4. Functionary (Ellul)

Men who had originally done the tailoring of garments had been gradually displaced by women at the sewing machine. They had taken refuge in the cutting room which became a male

preserve in which all the pre-assembly tasks were carried out. This was a strictly controlled craft with a long apprenticeship. This was the first point of attack for CAD. From the employer's point of view all technological innovation has to be seen as a tool with potential to weaken the power of the craftsman, or of any group that can hold the industry to ransom. This is done by a process of what I call job cracking by analogy with the cracking of crude oil which is turned into a more volatile and valuable compound and a tarry residue. When jobs are cracked (Fig. 274) the many male craftsmen are replaced by a male systems analyst and a set of female operators. The analysts are staff types and usually adopt the role of "servants of power" rather than the former role of "self-interested elite" adopted by the craft union.

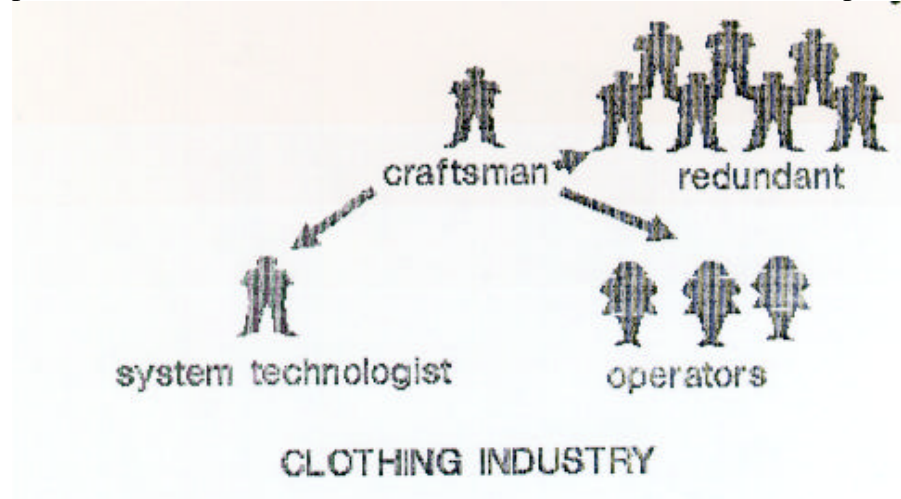


Fig. 274

The Old Craft of the Cutting Room

The business of turning fashion designs into working patterns was originally of course a purely manual craft.

Step 1. The pattern makers use cardboard master patterns (called blocks) representing the standard garments such as "ladies blouse with set-in sleeve". They adapt the designer's sketch to these and make a complete pattern on thin card for the standard size of garment, accompanied by detailed patterns for each of the parts: sleeve, cuff etc. with allowances for

seams. This is called "splitting" in the shoe industry. Incidentally, the process is just the same for shoes as for garments. You may recall the discussion of CAD applications to the Ontario shoe industry shown in the movie on automation.

Step 2. A standard pattern goes to a grader who adapts it to the full range of sizes using "grading rules" codified in a set of written tables based on experience of human anatomy. Obviously, if a person is a centimetre taller it doesn't mean they are a centimetre wider. For each size, separate patterns are made for each of the parts of the garment: collar, cuffs etc. As many as a hundred parts may be created. This job is, I suppose, the key to customer satisfaction in fit.

Step 3. These parts then go to the marker or lay-maker who lays them out like a jigsaw puzzle on a table which may be 30 m long. The marker's job is to maximize the utilization of a bolt of cloth while observing certain constraints such as the direction of the pattern or the weave. Fabric costs amount to, on average, 50% of the costs of making a garment. Therefore this job has key economic importance.

Effect of CAD

EFFECT OF CAD ON GARMENT DESIGN AND PRE-ASSEMBLY

- Block images stored in computer
- Grading technique replaced by expert system
- Percentage wasted computed and displayed for each layout
- Fabric pattern constraints incorporated in the program
- Learning system incorporated
- Lay-makers deskilled
- Cutters replaced by CAD/CAM
- Women take over as operators
- Wages reduced

All the jobs described so far lend themselves ideally to computerized graphics.

The master patterns or blocks can be stored as images in the computer and called up as required, together with a list of each of the pattern parts for that block. With the use of a light pen, each part can be brought up in turn and enlarged on the screen. This job obviously retains its skill and even requires the added skill of computer operation. With interactive graphics the pattern maker can now adjust each part to match the designer's concept.

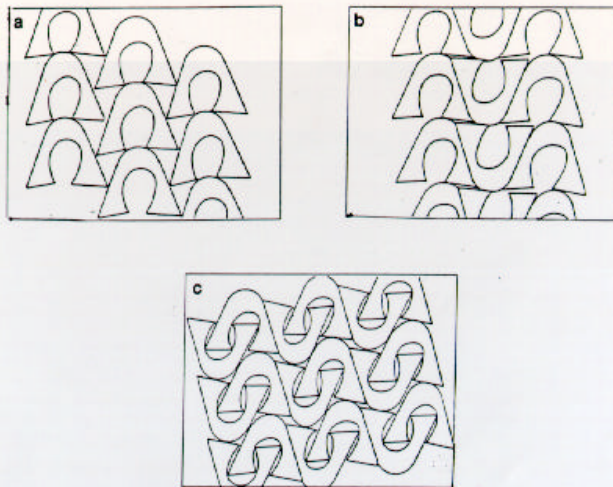
The grading technique, developed by graders over many years in the form of tables, has been entered into the computer for use in a primitive expert system, so that grading is now automated. The skill has been appropriated and the job has been deskilled.

Finally, the layout or marking is done by an operator working at the VDU. At each trial he/she can be supplied with a computed ratio of cloth used to cloth wasted. The optimization technique has a learning routine, so that the operator's skill is gradually incorporated into the program as a rule base. Each time the program is used it therefore

accomplishes its task more rapidly and further deskills the operator.

A radically different approach can be taken in which the problem is solved by an algorithm developed by a highly skilled technician of another discipline - say an industrial mathematician.

This would be the approach adopted in a window factory to computer the optimum cutting pattern with minimum wastage for an order of window panes. In these cases, of course, the old craftsman is simply scrapped. This is important because the same distinction is applicable to the programming of robots. To illustrate, Fig. 276 shows three possible arrangements for the cutting of shoe vamp¹³. The second and third assume a cutting tool that can rotate 180 deg. These were developed using theorems in pure mathematics.¹⁴



Cunninghame-Green, "Geometry,
shoemaking and the Milk Tray problem".
New Scientist, 12 August 1989, 50-53

The result of these technological changes has been to allow women to follow the keyboards into the cutting room as CAD operators. Not only are some of the jobs deskilled but wages are lowered across the board. Such a strategy is said to be essential if the domestic garment industry is to compete with the third world. But things are not always what they seem. Take the case of Vogue Brassiere who have closed one of their two Canadian factories and moved production to Mexico. Zeller's sell two lines of Vogue Brassiere, one made in Canada with the seams turned over and stitched, retailing in 1992 for \$20.50, one made in Mexico with serged edges (an inferior way of finishing) retailing at \$19.50. The wages in Canada are \$8.00/h those in Mexico 50c. Who pockets the difference?¹⁵

The completion of the automation of the cutting room is achieved by linking the CAD

system to an automated, digitally controlled, cutting knife able to cut 200 layers of cloth at a time. This is being replaced by a cutting laser with much greater accuracy where the fabric permits.

Interviews with managers have revealed that they feel the benefits come as much from enhanced control of both human and material "resources" as from savings in the wage bill. As one manager said "It puts management in the driver's seat". There are also savings in fabric costs as the layout routine is claimed to perform consistently at the level of the best markers.¹⁶ This is not yet the case at Kids Only, where the final adjustments are done by the operator (usually by inserting gussets in the blank spaces of the layout).

Assembly Phase

The mechanical sewing machine became a commercially available device in 1851¹⁷. It was widely advertised as a household appliance that would free women from the chores and drudgery of hand sewing. It would allow the needy and indigent to be clothed 100 times more effectively than from "the united fingers of all the charitable and willing ladies collected through the civilized world". The author of that panegyric evidently thought that the same people would use machines as had previously used needles. Reality turned out otherwise. With the help of the new machine, sewing came to be done in a factory setting and the machines came to be synonymous not with liberation but with exploitation. Not much changed in those factories for the next 100 years.

<p>POST-ASSEMBLY Finishing Pressing Packing</p>

The assembly process by sewing has proved recalcitrant to radical innovation and only a few of the 45 different types of sewing machine have received incremental innovations in the form of microelectronic (NC) controls. The one operator-one machine link is unbroken. Some special purpose machines have been introduced but experience has been poor because they would not adapt to new materials. In place of advanced technology much of the clothing industry has therefore intensified the division of labour. A garment may pass through the hands of 20 detail labourers, each contributing a seam or two. The opportunity for Taylorism is evident. But that it doesn't have to be so is illustrated by the factories of Levi Strauss. These are big plants employing 1600 unionized employees, mainly women and mainly immigrant.¹⁸

Many firms have outsourced the assembly phase to less developed countries. Liz Clairborne is a notable example. Some of her clothes are assembled in Mexican border factories by child labour under armed guard and draconian conditions of work. But now the effect of information technology, enabling central control of dispersed operations, has shown its "reverse potential". "Agile manufacturing enables a radical de-institutionalization of work

once the work itself has been computerized to McJob like status - that is, when its operations are determined and controlled by the computer system. In the garment industry at least, this is resulting in more women working out of their homes both nationally and internationally while garment factories are being closed in countries such as Mexico and Nicaragua."¹⁹

The following account of the effects of home work are quoted by Heather Menzies from a work I have not yet consulted²⁰:

A survey of working conditions among garment trade homeworkers in Canada found that 21 out of 30 were being paid less than the minimum wage, and 27 out of 30 were experiencing health problems: physical allergies from the dust plus mental stress from the piecework production demands. They were also working in poor ergonomic conditions as they carved a work area out of a space designed for sleeping, eating and living. They worked long hours - averaging 46 hours per week, with this rising to 70 h during busy periods. Labour law excludes them from overtime pay provisions, and many relied on other family members - child labour - to get the work done in time. Most had resorted to homework because they couldn't find or afford child care. As well, only one woman in the survey could converse in English which the researchers interpreted as racism reinforcing sexism to marginalize immigrant women.

Why has the automation of the garment industry been so slow? There is a complex set of structural, behavioural and technical constraints.

1. Structurally, the industry is characterized by a large number of small firms which cannot afford the capital costs. Annual sales of over 20\$M (1987) are needed to justify even the innovation of CAD/CAM. Of course, that is not out of line: Kids Only of Calgary expected to gross \$9 to \$10 million in 1994, the last year for which I have estimates. But one wonders whether the smaller firms could not adopt the solution discovered by the Ontario shoe industry for pre-assembly work, namely: to create an industry cooperative CAD Bureau?. Perhaps the extremely rapid fashion changes in the clothing trade compared to the show trade make that unworkable.

Management is prejudiced against the automated sewing machines from poor early experience. The makers of the machines came from a background in mechanical engineering and lacked the know-how of the microelectronic controls that are the secret of success. The most important recent moves are the entry of electronics firms into the design of machines.

On the other hand, the trend is now to concentration of industry. The 20% reduction in the number of manufacturer's of women's clothing in Montreal during the period 1980-1990 perhaps reflects this. The Schumpeterian principle of large firms risking innovation applies. An excellent example is provided by Peerless Clothing in Montreal with annual sales of over

100 M\$ of men's suits and pants mainly in the USA. In each of the years 1990-1994 the company added at least 1 M\$ of computerized equipment. The secret to their success is fusing rather than sewing. This technique was developed in Europe and substantially funded by the European Economic Community where a generation of suit tailors, who were traditionally Jewish, had been murdered. However some of these new fusing and gluing techniques are dependent on the use of synthetic fibres. A Nepean knitwear manufacturer to whom I spoke in 1992 had just installed a line of this equipment when, in the late eighties, fashion swung back to natural fibres and she had to scrap the lot.²¹ However, flexible knitting machines now permit a changeover to a different model in only 13 minutes, whereas before it took 3 h to alter the set-up.²²

MITI in Japan has a major project with tens of millions invested to develop FMS for the garment industry and three-dimensional sewing machines. Their strategy is not really to make cheaper clothes domestically but to dominate world trade in manufacturing the automated equipment.

Post-assembly

This stage can become a reverse salient if it does not receive the attention given to the more glamorous design and production phases. Overnight response is required at the Benetton works and a five day turnaround from the receipt of a custom order is the target at Kids Only. Outsourcing the task is one profitable solution adopted at Kids Only. United Parcel Service have installed a computer-controlled addressing service in the factory. This provides a bar-coded label which is used to route the parcel to its destination by UPS.

Impact on Workforce

We have seen some of the structural and social effects of these changes. Let me conclude by reporting some of the reactions from the shop floor.

It has been reported that the net effect of the new technology has been to increase the boredom of the work. A woman who had been promoted from the shop floor to the computer console complained that there was far less opportunity to move around and to socialize; "It's just you and your computer, and that's it". Nevertheless, as with all craft occupations, the old skills were undoubtedly over-rated and mythologized; they were used as a stratagem to strengthen both the union and male dominance.

One measure of the loss of craft control is the new vulnerability to speed-up. Essentially the shift to computerization is a shift away from a worker-controlled pace of work; this is in line with Marx's observation on the difference between tools and machines. The most important variable becomes machine utilization and up-time, rather than worker

efficiency. There is constant speed-up.

A number of factors may slow down the trend toward the penetration of the work place by women. One is the introduction of night shifts. A report from Britain indicates the concern of employers for the plight of young men and the availability of male succession to management. I don't think that would apply so much in Canada. The presidents of both Canadian companies I have studied are women. The garment industry provides a good case history of evolving gender relations in the work place in the course of a radical technological change.

Response to globalization

The automation of the garment industry seems to have had little effect on the aggregate trade figures but it has a significant impact on individual firms and has even managed to reverse the trade flow in some items like hosiery and jeans. It seems that the difference between the Best Domestic Practice and low cost imports is only about 10%.

If a global strategy of competition is adopted, what factors work toward the survival of Canadian manufacturers? Even though child labour is widely employed by the competition, there is a move, by North American outsourcers, not to encourage this and, by the public, to boycott manufacturers who permit it. In other developing countries there is a rising trend in real wages.

The design intensive direction taken by this market favours the North American manufacturer because of proximity to market. The number of collections per year has increased to at least four and several hundred styles may be shown at each collection. Successful firms like Benetton are convinced that rapid response to fashion change requires home-country production. Benetton's technology is referred to as the "quick-response" model with point of sale equipment linked to the Information Highway. It is a model of integrated production, distribution, marketing and even consumption based on continuous marketing and market feedback.²³ Benetton boutiques selling over a thousand designs have become Best Practice for sportswear. Very high managerial skills are needed to cope with such rapid change. In other words, the strength required in this labour-intensive fast-moving industry is creativity and disembodied technology and it appears that European and North American managers have this technical edge. New embodied technology that will radically change the technology of garment assembly may yet appear out of Japan.

Study Guide

1. What special features of the garment industry make the assembly phase difficult to automate?

2. Describe some changing power relations in a garment factory as the result of automation.
3. What is the role of "informating" in the assembly phase of garment manufacture?
4. Give an example of McLuhan's "reverse potential" from developments in the assembly phase of garment manufacture.
5. What strategy would favour Canada in the globalization of the garment industry?

End Notes

¹©P.Fitzgerald-Moore, 1996.

² Cockburn, Cynthia. Machinery of Dominance: Women, Men and Technical know-how London: Pluto Press. See Chapter 2 A wave of women: new technology and sexual divisions in Clothing Mfr.

Hoffman, Kurt (1985). "Clothing, chips and competitive advantage: the impact of microelectronics on trade and production in the garment industry. World Development, 13, 3 371-392.

³Menzies, Heather. *Whose Brave New World: The Information Highway and the New Economy*. Toronto: Between the Lines, 1996.

⁴"Ontario politicians hear union's tale of two bras" G&M 9Apr93.

⁵"Quebec garment firms show signs of wear" by Barrie McKenna; G&M Feb 1990 B-1, B4.

⁶Equally true in UK (Cockburn, 45)

⁷"Ontario politicians hear union's tale of two bras" G&M 9Apr93.

⁸Change Page 28 July 1982. English lessons, flex time, teams etc.

⁹Menzies, Heather. *Whose Brave New World: The Information Highway and the New Economy*. Toronto: Between the Lines, 1996.

¹⁰"A mother's journey: from legal briefs to children's jeans." G&M 17Jan94, B4.

¹¹Brain Storming by Michael Kay. G&M 6Apr93 p.B24. (Change Page).

¹²The Change Page G&M 14 Jul 1992

¹³"Geometry, shoemaking and the Milk Tray problem" by Ray Cunninghame-Green. New Scientist. 12 Aug 1989, p.52.

¹⁴Fedorov's theorem tells us that there are only 17 possible repetitive arrangements of a pattern, and the Hungarian mathematician Fejes Tóth showed that for a given class of convex shapes the best W1 arrangement will never use the material more efficiently than the best W2 arrangement (assumes large sheets of material).² And this rule is generally the case for non-convex shapes too.

¹⁵Ontario politicians hear union's tale of two bras" G&M 9Apr93.

¹⁶ In the OECD classification this counts as intra-sphere automation, since the three activities described are all part of one sphere of production, namely, the cutting room.

¹⁷Ursula Franklin; but based on a primary source.....

¹⁸Details on Change Page 28 July 1992

¹⁹ Menzies, Heather. *Whose Brave New World: The Information Highway and the New Economy*. Toronto: Between the Lines, 1996.

²⁰Barbara Cameron and Teresa Mak "Chinese speaking Homeworkers in Toronto," Summarized in *From the Double Day to the Endless Day*, p.20

²¹Knits Etc. (Robina Nicol)

²²Mytelka, p.112

²³ Menzies, Heather. *Whose Brave New World: The Information Highway and the New Economy*. Toronto: Between the Lines, 1996.