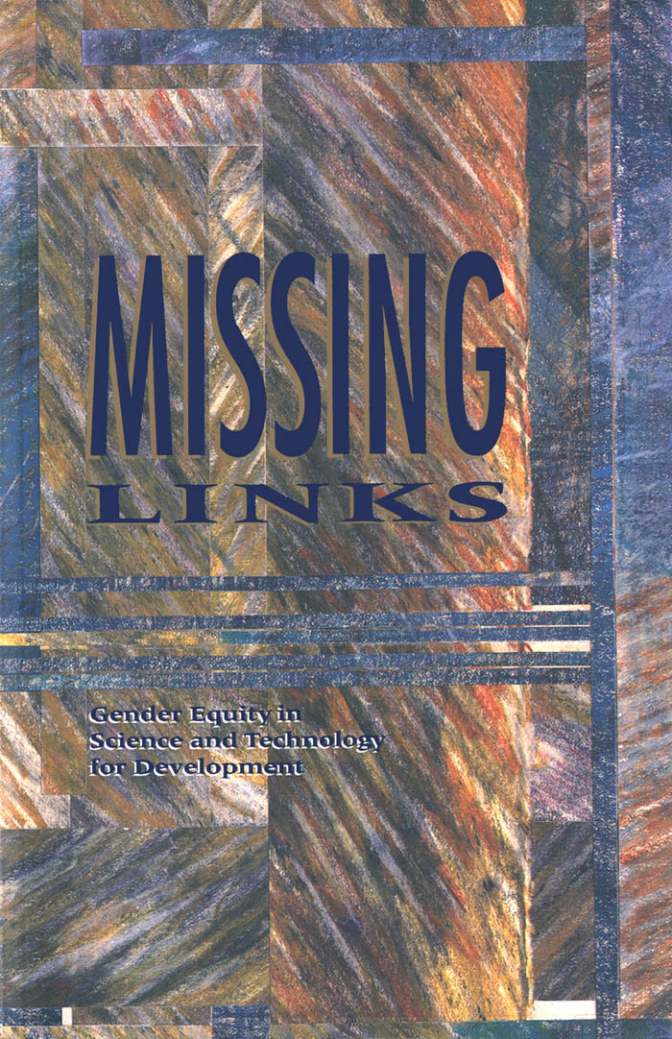
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This book is dedicated to Stanislas Ruzenza,
a member of the Gender Working Group.
Professor Ruzenza died in June 1995,
a victim of civil strife in Burundi.

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Chapter 10
Who benefits?

Measuring the differential impact of new technologies

Swasti Mitter

Technology is becoming pervasive in the lives of working women, even in the poorest countries. Udogini, a nongovernmental organization (NGO) in New Delhi, assists and trains small-scale vendors and self-employed manufacturers — mostly women — in business skills and marketing. In their intense struggle for survival, these women now make use of computer-assisted financial accounting, through the efforts of Udogini. The organization is by no means at the cutting edge of technological change. Inexpensive, older models of computers and systems, bought and maintained with funds from donor agencies, are enough for its present needs. However, the activity highlights the way in which the efforts of NGOs, donor agencies, middle-class organizers, and women themselves make it possible for women who are usually excluded from the benefits of information technology (IT) to use them in a cost-effective way to improve their economic position. None of the members of Udogini had either the resources or the expertise to use the accounting system individually, but together they were able to take advantage of it to improve the efficiency of their organization and its membership.

In the context of the ever-expanding role of new technologies in the lives of women and men in poorer countries, this paper aims:

- To highlight the relevance of new technologies in improving the quality and quantity of women's employment in the modern sector;
- To identify the differential effects of these technologies on women and men;
- To explore the reasons, social and economic, that lead to such differential impacts; and

- To help national and international policymakers locate effective points of intervention for redressing gender imbalances in the structure of paid employment, in collaboration with the corporate sector and women workers' organizations.

Relevance and definition of new technologies

The term "new technologies" refers to recent developments in computer-aided systems and some types of biotechnologies. In the broad spectrum of technological developments, new technologies encompass mainly areas where mode of production depends on storing, retrieving, and applying knowledge and information. Whereas some modern technologies are labour-intensive and some capital-intensive, new technologies are primarily knowledge-intensive. In many ways, their effects are similar to those experienced in the wake of previous innovations in production. However, unlike other technologies, they assume and demand certain cognitive skills among workers. Women's exclusion from scientific, technical, and business training thus limits their opportunities to participate in paid productive activities in all societies, including the poorer ones, where the spread of these technologies has been or is likely to be wide.

Do women, especially women from developing countries, need to bother about the possible effects of new technologies or, for that matter, of all modern Western technologies that support and are supported by Western capital and patriarchy, which exploit nature, women, and the poor (Shiva 1989, pp. xiv-xx)? Ecofeminists, postmodernists, and advocates of indigenous knowledge systems, among others, are understandably skeptical about modern technologies that are male oriented, Eurocentric, and antipoor. Given the havoc modern technologies have played in the developing and developed world, many concerned people plead for consideration and appreciation of indigenous technologies, which are embedded in a country's cultural traditions and, as a result, are more appropriate to the needs of women and the poor.

The focus on the effects of new technologies in this paper does not imply total endorsement of these innovations. However, I am against an uncritical rejection of knowledge systems that could, with vision and tenacity, be made compatible with the values and needs of different interest groups in human societies (Mitter 1994). Only increased cross-fertilization between indigenous knowledge systems and formal science will produce a paradigm of science and

technology (S&T) that is geared to the needs of men and women alike.

It would be unwise to deny that modern S&T have benefited women immensely, even those in developing countries. They have opened up new career paths for women, lowered the mortality rates of children and adults, and allowed women to control (albeit to an imperfect extent) their own fertility. On the other hand, advancement in formal technologies has also made women's traditional skills redundant in the workplace and brought unforeseen health hazards into the productive and reproductive spheres of their lives. Faced with such complex and contradictory effects on women's lives, it is not easy to formulate strategies that are universal or ahistoric. However, one can safely predict that only women's increased autonomy and choice — in the workplace as in the domestic sphere — will be likely to redress male bias in the current technological trajectories. The employment implications of new technologies assume a special importance in the context of augmenting women's autonomy and choice. Women's limited access to paid employment and corporate networks explains the current gender bias in the adoption of technology.

It would be rather unwise to promote a universal utopian feminine vision of S&T. Women, even in a single given society, do not form a homogeneous category. The needs and experiences of different groups of women require serious study, especially in relation to policymaking. In their dual role as mothers and workers, however, most women do face certain common difficulties. The reproductive role of women, to a large extent, explains differential effects of technological changes on women and men.

Trade flows and technology transfer

The adoption and diffusion of technology depend primarily on decisions at the firm level, but macroeconomic policies often define the environment in which firms make those choices. In the context of new technologies, the most important policies, by far, are those determining the flow of trade, particularly between developed and developing countries. Almost all research and development (R&D) is carried out in the developed world, and technology is transferred through trade, which encompasses buying and selling machinery and knowledge through licensing, patents, direct foreign investment, and the sale of "turnkey" projects, in which software is embedded in the equipment bought.

The linkage effects of technology transfer are complex and depend on the quality of workers and the infrastructure in the countries concerned. In some countries, particulary in east Asia, the driving force behind the adoption and adaptation of new technologies was, at least in the initial stage, to move up the learning curve through "reverse engineering" or "unpackaging the black box." Given the complexity of new technologies, the prospect of moving up the learning curve may not be so easy for countries that have only very recently embraced knowledge-intensive modes of production.

Trade in technology also depends on the national and international legal framework that determines the pattern and volume of exports and imports. In some countries, restrictions on importing foreign hardware, partly to protect the domestic industrial base, have affected the rate at which new technologies are adopted in the process of modernization. The pattern of industrialization, and of women's employment in the urban industrial sector, changes when an economy opens its doors to international competition. The international legal framework related to trade, incorporating such issues as intellectual property rights, determines the extent to which developing countries may be able to adopt the technological breakthroughs experienced and implemented in the more affluent parts of the world.

In this externally constrained environment, technological diffusion, through trade, alters both the comparative advantage of countries and the gender structure of employment. In the short term, the major effect on developing countries is expected to result from agricultural biotechnology. Tropical export crops can be genetically engineered to allow them to be grown in temperate climates; or genetic engineering could produce lower-cost substitutes. For example, oil palm exports may be threatened by the development of canola. There may also be shifts of comparative advantage within developing countries, as those with more advanced capabilities in agricultural biotechnology improve their speciality or commodity crops faster than others, or displace imports from other countries. For example, genetic engineering may be used to shift coffee production from Africa to Southeast Asia; virus-free clones of cardamom are likely to have a significant effect on the relative competitiveness of the leading producers, India and Guatemala.

Examining the differential impact of trade flows with respect to gender and region will be necessary to ensure equitable distribution of the costs and benefits of technological changes. A methodological framework for such an evaluation should be part of the future research agenda. Such an evaluation will be pertinent also in making a case for "managed trade" — trade that is not quite "free," but

subject to careful planning — on the grounds of distributive justice, in all spheres including employment (Beneria 1993).

Impact of technological changes

Advanced technologies alter the position of women in the world of paid work through: replacement of direct labour, changing skill requirements, and innovative work organization. It is useful to assess the impact of biotechnologies and computer-aided technologies in relation to these three areas.

Biotechnology: friend or enemy of women?

Although often described as a recent scientific breakthrough, biotechnology has a long history. It refers essentially to a set of processes that involve the use of biological organisms. First-generation biotechnology generally refers to such processes as fermentation. Second-generation biotechnology emerged around the 1930s with the advent of petrochemicals and later antibiotics. Third-generation biotechnology, which I deal with here, is based on the systematic manipulation of material at the level of the genetic code. This biotechnology is expected not only to have wide applications covering a variety of industrial sectors and markets — pharmaceuticals, plant and animal agriculture, speciality chemicals and food additives, environmental applications, commodity chemicals and energy production, and bio-electronics — and to open up a range of new (and currently unforeseen) possibilities in the future. Changes in the first three of these areas will have the greatest effect on the structure of women's employment, in developed as well as in developing countries.

Studies of the employment implications of agricultural biotechnology have often focused on the differential effects on small farms and large-scale plantations. Potential or actual effects on men and women have generally not been discussed despite the current economic importance and potential vulnerability of women in biotechnology-related industries (Ahmed 1992). Even radical feminist literature has yet to systematically examine the gender implications of biotechnology (Mies and Shiva 1993). However, this type of research is critical to inform policymaking in developing countries. The pharmaceutical and food-processing sectors may be the most appropriate initial foci because technological and market developments are the most advanced in these sectors and, therefore, effects are likely to be apparent soonest; and their effects will particularly

affect women, who form a large proportion of the workforce in these sectors in developing countries. Although women's use of new techniques of biotechnology has so far been insignificant, the technology is relatively cheap and is already spreading.

Improved methods of agricultural and industrial production in industrialized countries will adversely affect the level of employment in developing countries by displacing more traditional products from the world market. In the sugar industry, for example, fructose from maize grown in industrialized countries is emerging as an economically feasible and widely used substitute for cane sugar. This has spelled disaster for cane sugar-exporting countries, as they can no longer control the price of exports or compete in quality. They are losing an export crop and the workforce involved in sugar-processing industries faces redundancy.

The rapid commercialization and worldwide distribution of the genetically engineered herbicide-resistant plant varieties will lead to the increasing use of chemical herbicides in place of the manual weeding performed by the female waged labour force. The use of tissue culture has distinct advantages over the traditional technique of extracting chemicals from plants. Artificially grown tissues yield products that are more easily purified and both quality and quantity are predictable. As a result, these techniques will probably be used more frequently, even in some developing countries. This shift from field to laboratory, however, will be accompanied by reduction in the workforce. Tissue culture factories are unlikely to generate significant employment, as they are highly automated.

It is too early to assess fully the implications of the introduction of biotechnology on the structure of industrial employment; yet emerging evidence indicates that new jobs will be ones that require a high level of technical skill and managerial competence. Consequently, women's prospects for retaining their share of employment in industries, such as food processing or chemicals, will depend on the following factors:

- ✦ The ability of developing countries to create an institutional and educational infrastructure to teach the necessary skills;
- ✦ The success of developing countries in resisting recent moves to impose intellectual property laws on the fruits of the research undertaken in developed countries; and
- ✦ The willingness and support of national governments and intergovernmental organizations in extending opportunities to acquire relevant skills to women as well as men.

Displacement of female labour from paid work is likely to be accompanied by the increased use of unpaid female family labour.

Scale-neutral biotechnology, unlike Green Revolution technology, will be much more accessible to small farms, which depend on the unpaid services of family members.

Biotechnology opens up fresh challenges for the generation of technology as much as for its application. Women currently are far more visible in the field of biotechnology than in other "high-tech" sectors. Although, on average, women are underrepresented in tertiary education, their proportions are highest in the biological sciences. Women dominate the micropropagation laboratories in Mexico and the Philippines; women constitute 74%, 80%, and 85% of the membership in the Philippine societies for Cell/Molecular Biology, Microbiology, and Biotechnology, respectively (Halos 1992). One reason for this concentration of women scientists is that jobs in biological sciences have been considered low-paying, concerned with basic science and with limited links to industry (hence shunned by male scientists). Work in tissue-culture laboratories is also generally tedious, requiring patience and perseverance. However, the picture may alter quite drastically. If the rapid commercialization of patented biotechnologies brings large profits to the corporate sector, it may lead to better remuneration of poorly paid women scientists, although the higher salaries may then attract male scientists.

New biotechnology firms tend to be small and knowledge-intensive. Thus, they offer the potential of upward mobility to women in smaller-scale enterprises. However, there are also constraints, both to developing countries and to women. Although the production of knowledge as well as of goods can be undertaken in small firms in a cost-effective way, the marketing of products, an essential condition of success in business, is not so easy. Access to venture capital or to bank loans determines the viability of small companies; women's exclusion from such access, especially in developing countries, limits their opportunities. To remedy this, S&T education should go beyond purely technical training. An understanding of marketing, finance, and quality control will ultimately determine women's roles as entrepreneurs in the biotechnology business.

Retaining and expanding the roles of women in this area will increase a nation's endogenous capacity-building. It may also lead to a change in the direction of scientific research and its application to biotechnology. Scientific capacity in this field is currently being channelled toward the needs of the commercial world, and it may not be a coincidence that the most vocal arguments against commercially profitable, but socially and environmentally irresponsible, uses of genetic engineering come from natural and social scientists who are women.

Computer-aided technology

Although the use of biotechnology is still at the early stages in developing countries, computer-aided technologies have already affected the structure of employment. Combined with telecommunications and satellites, these technologies have changed the skill requirements, and the nature and number of jobs available to women employees.

Automated manufacturing

Computer technology has eroded the comparative advantages of developing countries. As computer-controlled machines take over work that was formerly labour-intensive, multinational companies are no longer locating plants in developing countries to take advantage of cheap labour. Currently, the flow of direct foreign investment is toward countries that provide cheap but *skilled* labour. Countries of the Association of South East Asian Nations (ASEAN) have been significant recipients of such investments: there, women have a relatively better chance of acquiring the requisite training and skills.

Domestic companies are also demanding new kinds of expertise in the wake of new technologies. Even in countries where there is a surplus of labour, manufacturing companies are adopting automated methods to achieve speed, flexibility, and quality control. As a result, even with the diverse patterns and directions of manufacturing jobs in all parts of the world,

- The cost of capital is rising;
- The input of labour is falling;
- Demand for multiskilled operators is increasing;
- New skills requiring hardware and software development are becoming important;
- Expertise in material resources planning and total quality management is proving crucial;
- Marketing skills are gaining in importance; and
- Skills in management of organizations as well as technologies are becoming essential.

Changing skill requirements often mean displacement of women workers, even in an expanding industry. In Malaysia, for example, the introduction of modern management systems in the semiconductor sector increased the demand for expertise in material control systems. Because of new management techniques, most firms in Penang have reduced machine set-up time, idle time, and

manufacturing lead time. Increased overall productivity, however, has meant a reduction in the proportion of women employed in the electronics industry of Malaysia. Whereas up to 80% of the workers were women in the industry's first development phases, by 1986 the proportion had fallen to 67% and it continues to fall today.

Computer technologies have affected the quality of women's employment as well. By decreasing the number of highly repetitive manual operations, computer-aided technologies have reduced the physical strain of assembly-line work. Yet, the increasing productivity rates achieved through technological progress have also reduced employees' opportunities to regulate their work rhythm (Mitter 1992). Frequently, workers have to work within ever narrower limits set by faster machines.

Assembly workers' tasks are becoming more versatile and changing qualitatively, from working on a manual assembly line to servicing and maintaining machinery and quality control. Thus, in the pioneer days of Thailand's electronics industry, employers needed the nimble fingers of women workers to connect tiny wires to a semiconductor. The same task is now being done automatically, with as many as 10 machines in the charge of just one woman. Labour content is decreasing, but the quality of labour demanded of electronics workers is rising (Financial Times 1990).

Changes in the organization of work

The nature and conditions of women's employment have also been influenced by changes in the organization of work at the enterprise level. Innovations in work organization have been prompted precisely by the need for continuous work flow to make the expensive technologies cost effective. At the corporate level, the trend has been toward "lean," quality-conscious management, based on the just-in-time (JIT) management philosophy developed in Japan, which stresses the benefit of reducing inventories and waste, both of materials and of final goods and services. Companies that have embraced the JIT philosophy follow a two-pronged policy: eliminate inefficiency and waste, in terms of defective work and waiting time, by streamlining the organization of work and diversifying employees' skills (internal); and establish an effective network of subcontractors ensuring fail-safe delivery of quality goods, services, or materials at all times (external).

Crucial to JIT policy is total quality control, including "zero" defects, after-care servicing, and guaranteed standards for products, aspects that are of key concern to the customers and thereby to the competitiveness of the companies. This philosophy is often referred to as total quality management (TQM) to emphasize the significance

of an integrated approach to quality in management policy (Roldan 1993).

TQM, or internal JIT management, presents contradictory possibilities to women employees. At the organizational level, the approach entails a transition from the traditional division of labour between different sections and categories of employment, toward integration of functions, skills, and experiences within a company. The key to success is viewed in terms of "interfunctionality" between different sections of the company, so that efficient communications among employees will improve the quality and timing of products and service deliveries. This paradigm shift in management practices demands of employees: complex and multiple business and technical skills; professionalism; high levels of education; and the ability to change.

As women are generally in the lower employment echelons and have limited access to relevant education and training, the introduction of TQM is likely to lead to their displacement in core enterprises. At least in principle, however, TQM holds promise as well. The move away from "Fordist" division of labour implies new flexibility in existing bureaucracies. The democratic approach requires employee involvement. TQM companies believe that the alienation of employees can be reduced by providing opportunities and training for self-development through resource centres, discussion groups, and action learning. These activities may give women confidence and polyvalent skills.

The impact of TQM and JIT on women at the "shop floor" level has not been sufficiently explored. The paucity of knowledge is even more marked in the context of developing countries. In some cases, the universal, undifferentiated application of TQM simply intensifies work and, thereby, health hazards for women employees. The increased expectations of employers often lead to physical and emotional stress. Under TQM, employees working in "quality circle groups" are expected continually to think of ways to improve the product. Although this forum allows women to contribute innovative, challenging ideas and to feel important or involved, there is fear that management gains from the experience of blue-collar women workers without any compensation for the added responsibility. In Argentina, when temporary technology groups were formed, they gave rise to stomach ulcers and nervous ailments among women (Roldan 1993). While juggling the demands of family and working life, women find it more difficult than men to cope with the expectations attached to the TQM approach. Thus, the JIT and TQM philosophy leads to a reduction in the number of women's jobs in the core

enterprises and the external goal exacerbates this trend by transferring some of the feminized jobs to smaller subcontracting units.

Information technology in the service industries

While robotic technologies, combined with new management practices, are posing threats of redundancy for blue-collar women workers on the assembly line, telecommunications and computer technology are opening up new avenues of employment for women in service industries. Stereotyped views of women's abilities have made them the preferred employees for all kinds of office work. Typing skills are valuable in many information-processing jobs. The entry of women into banking, insurance, and telecommunication industries has been impressive in both rich and poorer parts of the world. In some of the major foreign banks in India, for example, women make up 70% of the workforce (Gothoskar 1995); in the 1970s, the figure was only 5%. A similar increase in the proportion of women's jobs in the telecommunications sector has also been reported in Malaysia (Ng 1995).

In the printing and publishing industry, the proportion of female employment increased in both the United States and Denmark (ILO 1990b) with the introduction of microelectronics; in the United States, the increase was 56% in absolute terms. This gain by women was accompanied by a fall in male employment, as traditionally male jobs, such as linotype setting, now required the office-type skills of women, such as inputting text on phototypesetting visual display units. Even in poorer countries like Tanzania, women have made strides in the printing, publishing, and media industries, with effective use of computer technology (Haddon and Silverstone 1993; Alloo 1995).

However, there is a dire need for aggressive training programs for women in these new occupations in poorer countries. The shortage of people with computer-related skills is now being felt acutely in transitional economies, such as those of Romania and Vietnam, that have only recently embraced computer-aided technologies. African countries are facing similar problems. In one financial firm in Kenya, for example, nearly a third of the openings in the data-processing department remained unfilled (Mureithi and Ndiritu 1991).

It is not enough to give women workers one-time access to computer training. In this rapidly changing field, skills must be upgraded continually. Women's entry into new occupations has so far been mainly as clerks and typists. These are precisely the jobs that are likely to be automated in the next phase of technology development.

Women in these new occupations in the information and services sectors are generally from a different background than the blue-collar workers in manufacturing. Moreover, they are younger; the redundant female workforce in manufacturing is generally over 35. In formulating appropriate policies, it becomes important to note this polarization among women themselves on the basis of class background and age group. The field of software programming has opened up new opportunities, but for women from relatively privileged backgrounds. The proportion of women in this field is quite significant in some developing countries, such as Brazil (25%) and India (15%) (Gaio 1995). However, the proportion remains low because women often do not accept a challenging career because they see it as lowering their overall quality of their life. To entice educated women into these emerging fields, policymakers must encourage corporate bodies to experiment with flexible hours and work organization. The cognitive skills of women will be crucial both at the enterprise and national levels. Strategies to encourage women in the new technological fields would increase the competitiveness of countries in the international economy.

The telecommunication revolution and distant working

Modularization and miniaturization of products have made it possible for a large portion of manufacturing to be moved away from core enterprises to smaller companies. However, externalization of parts or all of the production process is not limited to manufacturing. Innovations in computers and office equipment, changes in telecommunications technology, and in regulation of telecommunications services have affected volume and structure of work. The increased flexibility offered by the new hybrid technologies has enabled major users of information processing to decentralize parts of their work. Large companies are able to separate the physical location of labour and space-intensive operations — such as invoicing, payroll accounting, stock control, sales records, market analysis, and routine accounting procedures — away from the headquarters of the company to a location where the cost of appropriate labour and office accommodation is considerably lower. The decentralization of office work has taken a variety of forms, referred to as "teleworking," "telecommuting," and "distant working."

A teleworker is usually defined as one who regularly works from home, using some form of telecommunications link to the outside world. However, such a narrow definition excludes a number of other interesting new forms of work organization, such as telecottages (neighbourhood work centres where a small group of

self-employed or employees share an office space), satellite offices, and teleservice centres. It is difficult to gauge accurately the extent of different forms of telework in advanced countries, and it is almost impossible to give any quantitative estimate of such work in poorer parts of the world. Scant information in this area confirms the view that the spread of electronic "homework" has been rather limited in the developing countries. There, even homes of white-collar workers are not often suitable for installing the equipment necessary for working electronically at home. Nonetheless, the prevalence and spread of such work has already been identified in South Korea, Malaysia, the Philippines, and Singapore (Kelkar and Nathan 1992).

In developing countries, decentralization of white-collar work is likely to result in satellite offices and in telecentres. The trend is already discernible and the implications of such work patterns are particularly significant for women. The experience of women in the more affluent parts of the world in this respect is fruitful for women of the developing world, where distant working in information-processing jobs is rather a new phenomenon.

It is difficult not to recognize a gender dimension in analyzing the social implications of telework (Wajcman 1988; Huws 1991; Haddon and Silverstone 1993). Technology that allows women to combine child care and homemaking with a reasonable career is, of course, a welcome possibility. In addition to spatial flexibility, teleworking, at least potentially, also offers the prospect of flexibility in working hours. In practice, evidence gathered so far suggests that women's gains in this direction, contrary to the dream of many futurologists such as Alvin Toffler, has not been substantial. In employer-led teleworking schemes, it is usually the employer who has control and the power to define how the employee should fit into a new set of flexible impositions (Huws 1991). Employees often end up working at unsocial times and for longer hours. Telework, especially if conducted from home, reinforces the traditional gender division of labour rather than being liberating (Haddon and Silverstone 1993). The freedom from domestic duties that often comes when women go out to work is lost. The duties and the tools of work conflict with the demands and the design of the home, causing stress both within work and the family domain. Men work "from" home; women work "at" home. In evaluating the impact of teleworking, one should bear this in mind.

Some of these problems become less relevant when work is done in small-scale satellite offices or neighbourhood centres. The problem of isolation is also less acute in this form of distant work. Yet, there are warning signs, especially when the skills content of these jobs is low and workers have little bargaining power. In Brazil,

workers employed at a decentralized (branch) office of a large public-administration agency found, for example, that lack of contact with the head office meant they had no input into determining skills and training needed and job content, in spite of the flexibility required from them in carrying out their tasks. Their work and performance was subjected to increased control, both by supervisors and by electronic surveillance. There was little scope for communication among workers, as a result of the physical fragmentation of the workplace into individual workstations. Data-entry clerks were forbidden to talk during working hours; they were allowed only short rest periods; and group solidarity was discouraged by a payment-by-results system, which encouraged an individual rather than a collective work ethic.

A survey carried out in Japan on the effect of working with computer terminals in banking and other sectors tends to confirm the pessimism generated by the Brazilian study. The Japanese office workers were convinced that their working conditions had deteriorated as a result of computerization. They complained of intensive electronic surveillance; restrictions on their physical mobility; high levels of exhaustion; and dissatisfaction with the monotonous and repetitive nature of the work (Pearson and Mitter 1993).

Bargaining power determines women's capacity to enjoy the advantages of flexibility that the telecommunications revolution has made attainable. In the absence of such power, telework becomes an extension of traditional part-time or piece-rate work — with similar insecurity and a marked absence of career progression. It is hardly surprising to find that the occupational distribution of telework is not very different from that found in traditional jobs. In Britain, a 1992 survey (Huws 1993) revealed that:

> Women make up nearly nine out of ten teleworking secretarial and administrative workers, three-quarters of writers and journalists and nearly two-thirds of training and education staff. They make up over half the home-based managers and sales and marketing staff, and half the researchers, but otherwise they are in a minority. In the case of engineers, this is quite a large minority, at 48%, but in other cases it is very small. Only 16% of home-based consultants are, on average, female, while women make up a mere 14% of home-based computer professionals. Among accountants and financial services workers the male majority is even more overwhelming, at 96%.

Even for professional women and men, telework often poses problems in terms of employment contracts. It is often difficult to establish whether a teleworker is a freelance consultant or distant

employee of an established business organization. The security and the benefits that an average employee derives from employment often elude the teleworker, who in many cases is reclassified as a freelance worker by employers.

Relocation of data-entry jobs

The creation of distant work is also related to the internationalization of the market and of information processing. There has been marked differentiation in the quantity and quality of relocated information-intensive jobs by region as well as by gender (Mitter and Pearson 1992). Despite a dramatic increase in the subcontracting of software programming work to a number of poorer countries, their overall share in the production of software has been small. Women's role in this sector has been minuscule. In contrast, women in developing countries have gained a major share of semiskilled data-entry jobs — especially when they have been relocated from high-wage countries.

Offshore data entry or data processing is the term applied to such relocation of new technology clerical work to low-wage countries. Pearson and Mitter (1993) give a comprehensive picture of the working conditions of women in these jobs. The major location of such activities has been the Caribbean, principally Barbados and Jamaica, and more recently the Dominican Republic, with a handful of facilities in Nevis, St Christopher, St Lucia, and St Vincent. Other facilities are known to operate in China, India, Ireland, the Philippines, and Singapore. Most of the foreign-owned subsidiaries in the Caribbean region and elsewhere are located in Free Trade Zones, in which governments provide incentives to foreign investors parallel to those offered to offshore manufacturing. Incentives available to foreign-owned data-entry firms in Jamaica's Montego Bay Free Zone include low-cost space, tax benefits, and full repatriation of profits and dividends to the home countries.

There are similarities in the working conditions of offshore data workers and teleworkers in industrialized countries, especially in terms of the insecurity of their contractual situation and earnings. In Jamaica, workers are frequently hired only after a lengthy period of selection and training, during which they are paid no more than a training allowance, although they are already processing data for commercial contracts.

Despite the precariousness of employment contracts and low basic-wage rates, total remuneration for offshore data-entry clerks often compares favourably with earnings in other local employment. A US-owned data-processing company in the Philippines advertised to potential clients that wages were pegged to the US

dollar and adjusted to compensate for any devaluation of the local currency. The minimum wage rates cited were comparable with those of local white-collar workers and professionals. However, in the early 1980s, such wages were 6 to 12 times higher in the United States than in Third World offshore locations (Pearson and Mitter 1993).

Employment in Free Trade Zones often precludes the right to organize. In Jamaica, no unionization was allowed among data-entry workers; in both Jamaica and Barbados, keyboard operators were encouraged to think of themselves as white-collar employees to preempt development of the militant characteristics of organized industrial workers. Management styles were often based on notions of responsibility for the employees' welfare, highlighting caring rather than conflictual relations between workers and management. In the Philippines, managers stressed the benefits granted to their employees, including bonuses, medical care, and profit-sharing plans, while confirming these employees' nonunion status.

Women's net benefits from the new jobs and novel work practices must be carefully evaluated. Most research in the field of technology has so far been geared to manufacturing and has lacked an appropriate focus on gender. A limited amount of research, undertaken by committed women academics, provides some basis for undertaking a more ambitious evaluation of the advantages and disadvantages of flexible service work.

Women in the decision-making process

Even in sectors where women have gained in terms of number of jobs, they have remained invisible in the decision-making process. Women are virtually absent from top management positions in both the developing and the developed world. Women's under- or nonrepresentation in the decision-making process is particularly striking in the new IT industries, which are relatively free of the historic gender-based division of labour and, therefore, where one expects women to fare better. In the large telecommunications companies of Europe, however, the gender structure is similar to that in traditional sectors. Women are predominant at the lower levels of the occupational pyramid, where jobs require less skill, little formal training, and are repetitive and tedious; they are less visible near the apex (Shapiro et al. 1995).

The reasons for this are complex. Women's invisibility in management positions cannot be ascribed only to their relative exclusion from formal technical and managerial education. An in-depth

analysis of career progress of women managers in two large IT-based companies in the United Kingdom revealed little difference in the formal qualifications of men and women junior and middle managers (Shapiro et al. 1995). The differential rate of progression may be a result of women's poorer understanding and grasp of informal promotion procedures in predominantly male-oriented organizations. Until a critical number of women reach senior-management positions, it will be difficult to change organizational culture.

The difficulty of reconciling family and working lives also poses a problem for women candidates for senior management posts. A demanding management job puts strain on family life; thus, women in all societies often choose family over promotion. By allowing flexibility of location and time of work, new technologies might be instrumental in reconciling the family and working lives of women. However, because of their underrepresentation at planning levels, women fail to negotiate such flexibility on their own terms.

Emerging management philosophies in the era of new technologies may create patterns and practices of work that will entice trained women to enter and progress in senior technical and management jobs. Qualities that have been considered feminine are now highly prized in IT-based companies, as they move away from assembly-line activities to group technology and teamwork. In some IT-based companies, management explicitly stresses the need for a feminine style of leadership to ensure TQM in processes and products. I am skeptical of such essentialism, but an open acknowledgement of women's potential contributions to management style may bring about a "woman-friendly" orientation in the pattern of work.

New technologies and small- and medium-sized enterprises

The introduction of information- and knowledge-intensive industries has contributed to the importance and growth of small- and medium-sized enterprises (SMEs) in all parts of the world. Small firms have often taken the lead in generating knowledge and marketing products; their role has been acknowledged in the field of biotechnology as well as computer-aided technology in general.

Knowledge-intensive small firms are most commonly found in affluent areas of the world. Even there, however, SMEs may find it difficult to enter, or maintain a share of, markets that are dominated by larger companies, who have greater access to capital and knowledge of the preferences of buyers. As a result, the knowledge-

intensive small firms frequently act as subcontractors, supplying goods and services not directly, but to large companies that dominate the market. Alternatively, they carve out a niche for themselves in a market where flexibility is of paramount importance. For example, microelectronic components, such as integrated circuits, are supplied by large-scale multinational corporations operating in global markets. In some areas, where barriers to entry are low, this globalization has allowed both large and small producers in developing countries, particularly in east Asia, to act as subcontractors of the multinationals. Production of electronic modules (peripheral equipment and consumer electronics) is a niche for SMEs in both developed and developing countries.

There are also opportunities for SMEs in certain segments of the high-tech service sector. Software development is the prime example. Generally, software is divided into three categories: systems software, applications software, and tailored software. Although systems software and, to a certain extent, applications software tend to be proprietary, barriers to production of tailored software are relatively low, making this area potentially attractive to small- and medium-sized firms.

The extent of women's role in these SMEs has not yet been documented. Currently, entrepreneurs in this area come from an elite educational background; women with such a background may be able to overcome some of the obstacles that poorer women generally face regarding access to knowledge, credit, and networks. A study of these women would likely reveal the kind of obstacles women face in occupations that are free of traditional expectations in terms of the gender division of labour. It may require a reevaluation of the nature and organization of a formal education that excludes women from vocation-specific technical and business training at all levels.

For poorer women in the developing world, the field of knowledge-intensive industry remains closed. However, they also face changes in the structure of businesses and production. Decentralization of production and the use of telecommunications technology in management opens up possibilities of entrepreneurship among women even in traditional sectors such as clothing, consumer electronics, and publishing. Challenges that women face in achieving a sustainable existence in these fields are not necessarily in the sphere of production. Their chief problem lies in their inability to respond to market demands. Even in richer parts of the world, the survival of SMEs depends as much on their "tangible" assets, such as technologically suitable equipment, as on their "intangible" investments in expertise to obtain technological and commercial

information (OECD 1993b). Innovation and flexibility are also crucial. Women in any society, especially in the developing world, have trouble acquiring such expertise and skills. An intervention by government and donor agencies to give women access to commercial knowledge and business skills would augment their opportunities in the SME sector.

The role of national and international policymakers assumes a special importance at this time, when in most countries substantial numbers of female workers are losing jobs in the formal sectors, because of world recession, technological changes, and lean management policies. Rising rates of unemployment in the formal sector are correlated with growth of self-employment in the SME sector. In Portugal, for example, between 1986 and 1990, during the peak period of recession, female entrepreneurship rose by a massive 48%. Self-employment, in many cases, is an alternative to unemployment — especially in societies where the cushioning of social assistance is absent.

In formerly socialist countries, the transition to a market economy is causing women to lose jobs at a much higher rate than men. This differential effect on men and women of a new economic orientation is visible in all regions: it is as pronounced in present-day Romania (Alatescu 1993; Sandor 1994), as it is in a socialist country such as Vietnam. In these countries, as elsewhere, women generally haver fewer qualifications and less training than they need to obtain technical positions. In the economic climate of shrinking state sectors, maternity leave and higher absenteeism among women make them a less-preferred workforce than men in the corporate sector. In this climate, basic computer knowledge and managerial competence would, to a certain extent, help women to sustain a career in SMEs in countries where the female literacy rate is reasonably high.

Labour standards and new technologies

In the context of new technology, the question of labour standards assumes an important dimension. Health and safety issues relating to the electronics industry have received some attention among both the workers and the policymakers (Chee Heng Leng 1992). Not only in the manufacturing sector, but also in the services sector, health hazards related to the use of video display units (VDUs) assume special urgency. These hazards particularly affect those working at the lower end of the office hierarchy: typists, telephone operators, and data-entry specialists.

Pearson (1995) has drawn attention to the way women academics have raised the issue of health hazards of VDUs with policymakers. A conference organized by the Women's Development Collective in Malaysia in 1993 provides a model of NGOs' effectiveness in giving these issues a high profile. By involving the Minister of Social Development and Unity, the conference paved the way for including health issues in the national policy dialogue on technology. The conference, attended mainly by workers, also included academics from Australia, Germany, India, Sweden, and the United States. The conference proceedings are aimed at disseminating this information to other non-European countries (Ng and Munro-Kua 1994).

In countries where the dissemination of new technology is not carefully monitored by government agencies, difficulties arise. For example, increases in foreign investment have opened up employment opportunities for many millions of women in South China; however, it has also led to much publicized safety hazards, such as fire leading to the death of young female factory workers. The increased incidence of fire has alerted national policymakers, women's organizations, and trade unions to the need to devise and monitor safety legislation for firms in the private sector.

Training in new skills for corporate jobs

The quality of women's employment and the number of jobs open to them depends on their ability to acquire relevant skills. Some skills are learned on-the-job, some through in-house training, and some in formal training institutes. However, in developed and developing countries, women are finding it difficult to enrol in formal training institutes (Acero 1995). The hours of training, the costs involved, and the structure of the courses conspire against them.

For young school leavers, the cost of training, especially in computer courses is the greatest deterrent (Banerjee 1995). Although an average family views the education of sons as an investment for the future, it perceives expenditure on daughters' education as a luxury. In most parts of the world, state subsidies are being withdrawn from postprimary schools. Thus, it is becoming extremely difficult for young women to continue expensive vocation-specific education. In certain countries, such as South Korea, daughters are expected to give their parents a certain amount of money before they get married. In fulfilling this traditional obligation, they enter the job market precisely at the stage when their brothers are getting vocational training.

There is a negative correlation between skill requirements for an occupation and the proportion of women in it. Since 1965, export-oriented *maquiladoras* on the United States–Mexico border have been employing mainly women who, with primary schooling, were suited for repetitive, unskilled jobs in the apparel and electronics industries. In the 1980s, however, changing conditions led to the need for more technical workers and engineers, and there was a concomitant fall in the proportion of women employed: from 77% to less than 60%. The downward trend continues (Hualde, personal communication, 1994).[1]

Women's relative exclusion from skilled technical work is a common occurrence. The difficulties of reconciling the demands of such jobs, which require continuous upgrading of skills, with women's commitment to running a home are often insurmountable. Studies of interconnections between the productive and reproductive spheres of women workers' lives, in their specific cultural context, would allow policymakers to identify appropriate points of intervention for ensuring women's access to tomorrow's jobs.

It is not easy to locate a model for training in the public sector, particularly in developing countries. However, there are some good examples of programs in the European private sector for retraining women workers facing the threat of technological redundancy (European Commission 1994). Policymakers in developing countries should examine, for relevance and efficacy, the range of programs now being collated by the Equal Opportunities Unit of the European Commission at the Directorate General of Employment, Education and Training.

Research agenda to guide policy

To ensure that women receive adequate employment protection and training in necessary skills, some areas of research must receive urgent priority. The mode of research should be participative, involving governments, NGOs, and federations of employers. Projects should be driven by demand and respond to the needs of both women and employers. No positive action will be sustainable unless it proves to be profitable.

[1] A. Hualde, "Trade flows, gender, and training in the maquiladora," El Colegio de la Frontera Norte, personal communication, 1994.

To this end, policymakers must ensure that:

- Technical training and retraining programs for women take note of the cultural and ideological constraints within their societies;
- The health and safety hazards facing women in new technology jobs are included in programs for national human-resource development;
- Women have access to knowledge and training that are relevant for small- and medium-scale new technology enterprises;
- They identify the cultural and organizational barriers that women face in entering managerial and technical occupations in high-tech industries; and
- Accumulated knowledge of the effects of technological changes on women's employment receives priority in worldwide dissemination.

Role and concerns of UN agencies

For nearly a decade and a half, the United Nations (UN) has been alerting national policymakers to these issues. In various reports, the UN has drawn attention to two disturbing dimensions in the current paradigm of technology:

- It fails to elicit and appreciate what women could contribute to modern S&T; and
- It overlooks women's specific needs and, thereby, affects women's opportunities and career progression adversely.

Even as early as 1979, the UN emphasized the importance of human-resource development for endogenous capacity building in developing countries. It encouraged policymakers to "facilitate constant training, development and upgrading of their labour force so that they may be better able to assimilate and benefit from the swift changes characteristic of the modern world" (UN 1979b, para. 34).

Later UN documents have consistently acknowledged the need to evaluate the differential impact of technological changes in the North and the South as well as on women and men. The report of the 1980 world conference of women, for example, advocated a worldwide "collaborative effort towards making science and technology a tool to eliminate rather than to amplify inequalities between

women and men" (UN 1980, chapter 1, section A). In addition, the report stressed the need to recognize women as an important component of a country's human resources and a source of technological innovation. *The Nairobi Forward-Looking Strategies* likewise made a case for women in the context of human-resource development plans (UN 1985b, para. 191):

> Their technological and managerial skills should be enhanced in order to increase self reliance in industrial production, and to promote innovations in productive design, product adaptation and production techniques.

Including women-specific issues in the policy dialogue was an acknowledgement of women's role as agents of change. Governments were urged to include women workers' organizations in policy discussion and to pledge their commitment to disseminating information regarding technological changes to workers to improve their negotiating power (UN 1984, para. 96).

> Concerned women scientists should establish linkages with women's groups to monitor and publicize the impact of new and emerging technologies on women's lives.

These reports have enhanced the awareness of UN agencies of the importance of the gender dimension in research and action related to S&T. The results have been impressive in some areas, but not in the field of new technologies. The International Labour Organisation (ILO) and the UN Industrial Development Organization (UNIDO) are most concerned with the role of women in technological change and industrialization. ILO has been more concerned with the context of new technologies rather than gender analysis. It has emphasized occupational safety and health hazards, and the implications of flexible employment for women, as epitomized by telework, in developed countries (ILO 1989b, 1990a,b, 1991c).

UNIDO has not yet focused specifically on the needs and potential of women in new technology industries; its most important contribution has been in stressing the need to take seriously the role of new technologies in women's future employment (UN 1989). In addition, UNIDO's (1993) study of the textile and clothing industry in Asian developing countries exemplifies the way gender awareness could enrich the analysis of industrial restructuring in response to computer-aided technologies.

A new research initiative

To redress the current gaps in research and analysis in this field, we have initiated a number of projects at United Nations University, Institute for New Technologies (INTECH). Between 1991 and 1993, the Gender and Technology Group at INTECH collected preliminary data and sketched a conceptual framework for analysis of the employment implications of new technologies in collaboration with 14 researchers from different regions of the world (Mitter and Rowbotham 1995). The latest phase of this work, focuses not only on collecting more information but also on adopting a novel mode of research, bringing together researchers and representatives of NGOs and governmental bodies to facilitate a policy dialogue centred on endogenous capacity building.

The primary goal of the project is to improve the advocacy skills of women workers' organizations, by giving them access to key knowledge. The project, which is partly funded by the UN Development Fund for Women (UNIFEM), is focused on Asia and is guided by the conviction that women who bear the consequences of technological and industrial policies should have an adequate voice in the formulation, implementation, diffusion, and evaluation of those policies. Its goal is to contribute toward ensuring that the countries, and women in them, benefit from the potential of new technologies.