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ABSTRACT

The first part of this report examines the relationship of technological change to employment and work. After a brief introduction, chapter 1 discusses new technology and labor productivity versus employment, emphasizing the effects of labor-saving machinery and changes in specific sectors of employment, such as electrical machinery, communications services, financial services, printing and publishing, and textiles and clothing. Chapter 2 looks at the effects of technological change on occupational structure and skills. Chapter 3 concerns coping with the effects of technological change on employment. The second part of the report looks at training for new technology. After an introduction, chapter 4 examines the issues involved in training under conditions of change and uncertainty. Chapter 5 discusses apprenticeship, project work, and "sandwich" courses that combine school-based programs with hands-on training. Chapter 6 gives a brief overview of four in-house training programs at Avionics, Corning Glass, Motorola, and Siemens. Chapter 7 gives an overview of technology training institutions that provide similar services for small and medium-sized companies in Switzerland, Germany, and the United Kingdom. Chapter 8 summarizes the issues involved in technological change and employment and discusses special consideration with respect to Eastern Europe. Several points for further discussion are offered. (CML)

International Labour Organisation

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Tripartite European Meeting on the Impact of Technological Change on Work and Training

Geneva, 28 Oct. - 2 Nov. 1991

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PART 1

TECHNOLOGICAL CHANGE, EMPLOYMENT AND WORK

INTRODUCTION

Technological change is occurring faster than ever, as a result of interrelated innovations in different fields of expertise and increased globalisation of produc·tion. Because of the pervasive nature of some new technologies, its overall impact has become increasingly difficult to grasp. The effects on employment and other aspects of work are not always clear beyond the plant or firm level and cannot be analysed separately from other socio-economic effects. One consequence of this is a lack of consensus about the long-term employment impact of technological change and about the ways employers, governments and unions can cope with the future challenges it may pose for employment creation, job security, social security and education and training.

While a relatively fast pace of technological change may be to some extent inevitable, the uncertainty about its long-term effects makes it imperative to ask whether the magnitude and rate of change are optimal for specific country conditions, and whether and to what extent such change should be guided by social choices and related policies.

These are questions of paramount importance for the future. Part 1 of this report, however, will focus on more tangible issues, such as how recent trends in technological change have affected employment, occupational structure and skills in European countries and what type of measures have been adopted to cope with these developments?

Even these issues are difficult to discuss comprehensively because European countries differs so widely in terms of level of development, economic experience and labour market conditions. While intensive research has been conducted on some countries and sectors, on others there is very little, and this inevitably determines the coverage of an overall survey. Moreover, because of limitations of space, the report will confine itself to a summary of findings from selected studies, many of which have been published by the ILO.

CHAPTER I

EMPLOYMENT EFFECTS OF RECENT TECHNOLOGICAL CHANGES

There has always been considerable disagreement about the employment and overall economic impact of technological change and, more recently, about the magnitude and nature of the effect of introducing advanced processes such as microelectronics, biotechnology and laser- and satellite-based technologies. Since the late 1970s an enormous volume of literature has emerged. Some of these studies have taken a pessimistic view of the recent wave of technical change which they see as unprecedented and tend to exaggerate the negative employment effects and to predict enormous job losses. Others perceive the recent developments simply as the latest stage in technological evolution, emphasising the numerous compensating factors that make up in part or in full for the jobs lost. Other studies again claim neither negative nor positive effects on employment but focus instead on the problem of adjusting to structural change and on the measures to promote a smooth adjustment.[1]

Many of the predictions that were made in the late 1970s and early 1980s were somewhat extravagant. One study of Germany (Federal Republic) forecast that 80 to 90 per cent of the workers in metallurgical industries in the state of Baden-Württemberg would be replaced by robots. In the United States one study predicted that industrial robots would replace 1.3 million workers, while another estimated that they would do away with 100,000 to 200,000 jobs by 1990 but would create between 32,000 and 64,000. These and other studies have been reviewed by the ILO.[2] The greater the level of aggregation of the analyses conducted, the greater seems to have been the tendency to exaggerate. The conflicting viewpoints derive from differing assumptions regarding such factors as: (a) the likely rate of diffusion of the technology; (b) the degree of direct demand creation and labour displacement; and (c) the possibility of compensation through price feedback or through government intervention.[3]

The more optimistic studies are not always very convincing either. Some macro-level analyses have overemphasised compensatory effects as a matter of faith rather than fact. At the micro-level, there has been a tendency to generalise from cases showing favourable employment effects. As one study rightly pointed out, optimistic assessments often stress that microelectronic machinery helps increase or maintain employment because without it the firm or industry would lose its market to competitors. This argument is weak because cost and quality improvements are also attributable to changes that take place simultaneously in many other domains (design, work organisation, production technology based on microelectronics, new materials, training, marketing, etc.). It is also loose, in that the result depends on the speed and extent of application of new technology, and on the efficiency in its use, relative to those of the competitors.

Those studies that focus on the problem of adjustment to change contain useful findings. A frequent shortcoming, however, is that they tend to view the rate of technological change as a given and unavoidable phenomenon without questioning whether the magnitude and speed of change is ideally suited to overall existing conditions and whether or not they could be modified.

Because of the difficulty of assessing the potential employment impact of technological change at relatively high levels of aggregation, the focus of research since the mid-1980s has shifted to detailed analysis of the actual level of diffusion of advanced technology and of its labour-saving effect at the enterprise levels. Much of this research, including many ILO studies, provides a balanced view of both the positive and the negative effects of advanced technologies. Although the level of analysis and the methods used do not always allow neat conclusions as to the net impact on employment and the overall economic effect, the findings do afford a general overview of trends and a clear picture of the direct employment effects of specific types of machinery in particular sectors. They also serve to identify certain means of coping with the negative effects of technological change.

By way of example, table 1 provides an overview of the main applications of microelectronics and their impact on employment levels.

Table 1. An overview of microelectronics applications and their impact on employment

Sector	Main applications of microelectronics	Impact on employment levels
Agriculture, fisheries and forestry	Minor improvements for better resource use, e.g. management information systems, reliable and portable instrumentation, and some possible automation to manage large operations.	Minimal impact since most labour was displaced in earlier shift to mechanisation. In advanced countries most impact will be felt with small increases in labour productivity.
Extractive industries	Minor changes in the short term, associated with improved monitoring and control and with safety; major changes in finishing rather than extraction where various processing operations may be automated. Shift in the long term to integrated extraction systems which may automate monitoring and control.	Minor impact in the short term since, as in agriculture, much of the labour saving occurred with mechanisation, and microelectronics simply extends this trend. Possibly greater impact in the long term as new integrated systems will permit extensive rationalisation and restructuring of the industry.
Process industries	Minor improvements in control and monitoring in existing processes, but new processes made possible by accurate automated control; increased integration of packaging and other finishing operations into overall production.	Minor impact in direct process operations since they require capital-intensive technology with limited manpower, but greater impact from integration of operations and in repetitive finishing operations which can be automated at low cost.
Mass production manufacturing, e.g. vehicles or consumer electronics	Some automation of monitoring and control functions which were previously too difficult or expensive to automate. Widespread use of computer control in processing, materials handling and management, and design. Reduction of the overall component count and simplification of operations.	Major impact in low-skill and repetitive tasks (e.g. handling of materials) and in more skilled shop-floor monitoring and management tasks. Increased integration of equipment and functions reduces staff while expanding their task range.

Sector	Main applications of microelectronics	Impact on employment levels
Batch manufacturing, e.g. capital goods	As above, extensive use of automation technologies in areas which it has not hitherto been possible to automate. Increased use of integrated configurations such as flexible manufacturing systems, which combine several functions and permit batch production to approximate a continuous flow process. Such changes allow for both flexibility and productivity.	Labour requirements decline with integration of multiple functions into automated systems (e.g. a CNC machining centre plus robot handling, plus tool management system may require only one or two operators instead of ten or more). Jobs increase in maintenance, production planning and computer programming. For many sectors, the main cost in such batch manufacturing is materials rather than labour and so investments in microelectronics may not necessarily cause massive job displacement.
Jobbing and small-batch manufacturing	Minor improvements due to more accurate and powerful tools (e.g. low-cost CAD and CNC) in what is largely a skill-based service activity.	Marginal or minor impact. In many cases the availability of new tools can enhance productivity but large-scale labour saving is unlikely.
Office work	Major changes through the use of integrated systems which exploit the networking advantages of microelectronics together with the increased use of telecommunications. Many large-scale national and international networks have been established which integrate activities and make them less location-specific.	Depending on redeployment and retraining policies, job losses may be large in repetitive and low-skill jobs in manufacturing and service sectors (e.g. data entry, routine filing and basic clerical duties) which are highly susceptible to increasing automation.
Retailing and distribution	Use of intelligent "electronic point of sale" (EPOS) tills; increased integration along the financial chain with direct links to banks, and automation of merchandise flows, leading to lower inventories and improved deliveries, etc.	Main impact is on routine clerical and distribution management tasks. Since much employment in these areas is often on a casual or part-time basis it is difficult to discern a major reduction in employment.
Transportation	Few changes, mostly in administration, e.g. in automated ticketing.	More impact on indirect support than on direct operations. Low-skill jobs (e.g. ticket issuing/collection) may to some extent be shifted to inspection and monitoring.

Sector	Main applications of microelectronics	Impact on employment levels
Public services	Major changes in general administration and resource management with computerised networking.	Substantial impact, but more from rationalisation than automation of clerical tasks.
Health care	Minor changes associated with advanced tools for diagnosis, monitoring and treatment; computerisation of health management.	Minor impact for those directly involved, but more serious for low-skill, routine clerical work (such as patient records maintenance).
Education	Main changes in administration and new tools, especially for "distance learning".	As above, main impact in the overall management and administrative areas rather than in the delivery system.

Source: Elaborated from J. Bessant: Microelectronics and change at work (Geneva, ILO, 1989), pp. 36-40.

New technology and labour productivity vs. employment

The adoption of new technologies usually involves an increase in the capital/labour ratio and an increase in labour productivity. This, however, does not necessarily mean that workers themselves become more productive - although of course output may increase - but rather that employment decreases per unit of capital invested and per unit of output. Critical questions, which cannot always be answered for lack of information, are whether the productivity of capital also increases; whether the new technology is more profitable to the enterprise at market prices than the technology it replaces; if market prices are distorted by subsidies, taxes or monopolistic pricing, whether the social cost of the new technology is justified; whether increased labour productivity boosts employment indirectly through a reduction in costs or prices or an increase in profit-derived investment.

Labour productivity can be raised not only by investment in new machinery but also, in some sectors and certain market conditions, by other means which can be equally or more effective: changes in financial and other incentives (e.g. profit/loss-sharing schemes, promotion based on performance, etc.), reorganisation of work, changes in inventories and in the flow of inputs used by labour, and training. Training can be regarded not only as a complement to new technology but also as a substitute in so far as additional training can increase the productivity of a worker without changing the technology used. As a substitute, it has the attractiveness of raising productivity while saving capital in new machinery and creating further employment in training staff and infrastructure. These various means have to be emphasised, particularly in countries where labour market conditions make it necessary to maximise employment levels for a given national income target.

In 1985 the ILO's Advisory Committee on Technology[4] stressed that advanced technologies reduce employment growth but also have compensatory effects on both the demand and the supply side. Since 1985 there has been further evidence that by and large the aggregate level of employment in industrial societies has not been greatly affected by the introduction of advanced technologies. The long-term trend of declining manufacturing employment observed in industrialised countries is certainly continuing, but only partially because of technological innovations that eliminate jobs (particularly unskilled work) and increase productivity. In Germany (Federal Republic), Japan, the United States and possibly other OECD countries job displacement resulting from rationalisation, new technology and work reorganisation appears to have been offset by redeployment in other activities and by new jobs created by advanced technologies. Where technological change is accompanied by economic growth, expanding markets and new investments, it tends to induce positive employment effects through the revitalisation of the economy. According to one study, between 1973 and 1985 technological change may have caused an annual growth of 290,000 new jobs in Japan and 960,000 new jobs in the United States but an annual decrease of 90,000 in France.[5]

Surveys of manufacturing establishments in the United Kingdom have been carried out by the Policy Studies Institute (PSI), whose latest report[6] reviews the findings of four major surveys undertaken between 1981 and 1987 and of case studies of 26 factories carried out in 1988/89 which explored the impact of advanced technology on job levels, skills, training and employees' attitudes.

These findings indicate that job losses directly attributable to the introduction of microelectronics-based technology have been smaller than those caused by economic recession and organisational changes - although in some cases these changes may have been promoted by new technology. The losses - mainly unskilled shop-floor jobs - were nearly three times as high in plants which were not using microelectronics as in those which were - 15 per cent compared with 4.5 per cent during 1985-87. More men have been displaced than women; more jobs have been lost in the larger plants than in small and medium-sized plants; and the more extensive the use of microelectronics in production processes, the more jobs tend to be lost. The sectors with the largest losses due to advanced technology have been food and drink processing, chemicals and metals, mechanical engineering, vehicles, aircraft and shipbuilding, and paper, printing and publishing. On the positive side, the surveys found that, for some types of work and in some industrial subsectors, job losses due to microelectronics have been offset by improved product quality and productivity. Job gains related to advanced technology have been concentrated among skilled craftsmen, technicians and engineers.

Labour-saving effects of advanced machinery

To have an idea of the employment consequences of advanced technologies or groups of related innovations used simultaneously (e.g. flexible automation) it is important to look into the effects of specific types of machinery, such as numerically controlled machine tools (NCMTs), industrial robots, computer-aided design and manufacturing systems (CAD/CAM), flexible manufacturing systems (FMS) and computer-integrated manufacturing (CIM).

NCMTs and robots in the automobile industry

Evidence from European countries suggests that, on average, one NCMT replaces two to three people when it is introduced as a stand-alone item, but between two and six people when installed as part of an FMS. (In Brazil, each NCMT replaces three to five workers.) Robots are known to save unskilled and semi-skilled labour in painting, arc welding, materials handling and vending services. ILO studies of the automobile industry have found that, on average, each robot displaced (in two shifts) 0.8 workers in France, 0.5-0.7 in Japan, 1.5-2 in the United States and as many as 3 in Italy's Fiat plants. This amounts roughly to 0.5-1 worker per shift, although some other studies mention from two to five workers. The number of jobs replaced by robots accounted only for 2 to 5 per cent of the overall change in the industry's employment between 1979 and 1984. The ILO case studies suggest that the actual labour saving accruing from the application of a new machine varies even within a company or plant, depending on the overall level of automation, the efficiency in work organisation, the nature of work assigned to the machine, the way it is used, and the quality of workers prior to its use. It is argued that, for these reasons, robots and NCMTs have been saving much less labour in the Japanese automobile industry than in the same industry in North America and Western Europe, even though the stock of such machinery is much greater in Japan.[7]

Advanced machinery in the engineering industry

The share of flexible automation machinery in total fixed investment in machinery and equipment in the engineering industry has increased at a significant rate and some concern has been raised about its effects on employment. For example, from 1978 to 1984 the percentage share of investment in NCMTs rose from 5.7 to 13.8 in Sweden, from 4.8 to 8.4 in the United Kingdom and from 2.7 to 8.3 in Japan. The share of investment in robots has risen much less over the same period and also much less in those European countries and the United States than in Japan: 1.3 per cent to 1.7 per cent in Sweden and even less in the United Kingdom, compared to a fivefold increase from 0.8 to 4.3 per cent in Japan (table 2).[8]

Table 2 summarises the estimated growth of NCMTs and robots and their possible labour-saving effects in five OECD countries, which must of course be viewed with caution since they reflect fragile estimates of the stock of machinery. These effects are numerically significant for long-term employment. However, they do not mean that the corresponding number of workers have lost their jobs, nor that actual employment in the engineering industry will have decreased accordingly. In some countries, the industry's employment may have decreased while in others only the employment growth rate will have fallen. This variation depends on the volume of jobs lost in relation to the industry's employment, whether the industry is expanding, whether the advanced machinery has increased competitiveness, etc. The estimated jobs replaced by NCMTs and robots constitute relatively small percentages of total employment in the engineering industry. In 1984, these percentages were 6.3 in Sweden, 6.1 in Japan, 2.8 per cent in Germany (Federal Republic) and the United States, and even less in the United Kingdom. It is noteworthy that the two countries with the highest percentages of jobs replaced also had the lowest overall rates of unemployment among the five countries.

Table 2. Estimated growth of flexible automation machinery in OECD countries and possible labour savings

	1978	1980	1982	1984	1986*	1988*	1990*
JAPAN							
NCMTs							
- Yearly investment (current US $ million)	227	733	1 066	1 567			
- Share in total fixed investment in machinery + equipment (%)	2.8	5	7.1	8.3			
- Units installed				118 157			
- Growth of units installed (%)							
- Density (per '000 workers) /1				19.8			
- Jobs replaced				236 314			
Robots							
- Yearly investment (current US $ million)	64	225	507	806			
- Share in total fixed investment in machinery + equipment (%)	0.8	1.5	3.4	4.3			
- Units installed	7 000	14 000	31 857	64 657	135 890	290 206	606 231
- Growth of units installed (%)		100.0	127.6	103.0	110.2	113.6	108.9
- Density (per '000 workers) /1				10.8			
- Jobs replaced				129 314	271 779	580 412	1 212 462
Total jobs replaced by NCMTs + robots				365 628			
Total jobs replaced as % of employment /1				6.1			
SWEDEN							
NCMTs							
- Yearly investment (current US $ million)	34	65	56	120			
- Share in total fixed investment in machinery + equipment (%)	5.7	6.4	7.5	13.8			
- Units installed				6 010			
- Growth of units installed (%)							
- Density (per '000 workers) /1				23.8			
- Jobs replaced				12 020			
Robots							
- Yearly investment (current US $ million)	7.7		10.3	14.5			
- Share in total fixed investment in machinery + equipment (%)	1.3		1.3	1.7			
- Units installed	415	795	1 400	1 900	3 188	5 097	7 872
- Growth of units installed (%)		91.6	76.1	35.7	67.8	59.9	54.5
- Density (per '000 workers) /1				7.5			
- Jobs replaced				3 800	6 376	10 194	15 745
Total jobs replaced by NCMTs + robots				15 820			
Total jobs replaced as % of employment[1]				6.3			
UNITED STATES							
NCMTs							
- Yearly investment (current US $ million)			1 557	1 286			
- Share in total fixed investment in machinery + equipment (%)			5.2	3.4			
- Units installed				103 308			
- Growth of units installed (%)							
- Density (per '000 workers) /1				12.2			
- Jobs replaced				206 616			
Robots							
- Yearly investment (current US $ million)			185	225			
- Share in total fixed investment in machinery + equipment (%)			0.6	0.6			
- Units installed	2 500	3 500	6 250	13 000	22 818	42 753	81 358
- Growth of units installed (%) /1		40.0	78.6	108.0	75.5	87.4	90.3
- Density (per '000 workers)				1.5			
- Jobs replaced				26 000	45 636	85 506	162 715
Total jobs replaced by NCMTs + robots				232 616			
Total jobs replaced as % of employment /1				2.8			
UNITED KINGDOM							
NCMTs							
- Yearly investment (current US $ million)	148	344	221	259			
- Share in total fixed investment in machinery + equipment (%)	4.8	7.6	7.3	8.4			
- Units installed				32 566			
- Growth of units installed (%)							
- Density (per '000 workers) /1				13.3			
- Jobs replaced				65 132			
Robots							
- Yearly investment (current US $ million)		10	26	39			
- Share in total fixed investment in machinery + equipment (%)		0.2	0.9	1.3			
- Units installed	125	371	1 152	2 623	5 972	16 623	45 245
- Growth of units installed (%)		196.8	210.5	127.7	178.3	172.2	159.4
- Density (per '000 workers)				1.1			
- Jobs replaced				5 246	11 945	33 246	90 489
Total jobs replaced by NCMTs + robots				70 378			
Total jobs replaced as % of employment /1				2.9			
GERMANY (FEDERAL REPUBLIC)							
NCMTs							
- Yearly investment (current US $ million)							
- Share in total fixed investment in machinery + equipment (%)							
- Units installed				46 435			
- Growth of units installed (%)							
- Density (per '000 workers) /1				12.4			
- Jobs replaced				92 870			
Robots							
- Yearly investment (current US $ million)							
- Share in total fixed investment in machinery + equipment (%)							
- Units installed	450	1 133	3 500	6 600	12 446	31 084	77 423
- Growth of units installed (%)		151.8	208.9	88.6	149.8	149.1	129.1
- Density (per '000 workers) /1				1.8			
- Jobs replaced				13 200	24 891	62 167	154 847
Total jobs replaced by NCMTs + robots				106 070			
Total jobs replaced as % of employment /1				2.8			
TOTAL JOB REPLACEMENT IN THE FIVE COUNTRIES				790 512			

Notes: * The 1986-90 estimates were calculated from the data until 1984 assuming the same coefficients. The growth rates of units installed after 1984 were calculated by taking simple averages of any previous three years shown.

/1 These figures are different from those in Edquist and Jacobson because those authors use 1980 employment data. We have recalculated these figures on the basis of the employment indices of the Economic Commission for Europe.

Sources: C. Edquist and S. Jacobson: Flexible automation: The global diffusion of new technology in the engineering industry (Oxford Blackwell, 1988), tables 7.2, 7.3 and 8.2 and Appendix tables 6.1 and 7.1; and Economic Commission for Europe, Engineering industries: Dynamics of the 1980s (New York, United Nations, 1988).

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CAD/CAM, FMS and CIM

The number and growth of CAD and CAD/CAM units installed in any individual sector is much less clear than those of NCMTs and industrial robots because of the rapid diffusion and the replicability of PC-based systems, all of which cannot be accounted for. Edquist and Jacobsson's study includes figures for CAD systems used in the engineering industry in the above-mentioned five countries in 1983-84 (though even this is likely to be an underestimate): 9,000 in the United Kingdom, 1,900 in Sweden, 7,300 in Japan and 59,400 in the United States. Another source reported 11,000 CAD/CAM workstations in different sectors in Germany (Democratic Republic) at the beginning of 1986, twice as many a year later and a target of 90,000 for 1990. It is, however, impossible to estimate the labour-saving effect of these workstations because of differences in application, capacity utilisation rates, etc. For the engineering industry the above study claims that CAD systems cause a threefold increase in labour productivity. The source for Germany's figures mentions a 25 and 80 per cent reduction in the design time for a new product, at least 15 per cent saving in material inputs, up to 60 per cent saving in overall costs and a significant quality improvement.[9] However, labour savings of up to 3,000 per cent per unit of output have been reported for different applications in various sectors. Most studies do not mention the time involved in reaching optimal efficiency, which may be long in some cases. The scant evidence appears to suggest that, in the short term, CAD/CAM does not reduce jobs, and does in fact increase the demand for programmers and designers with skills in computer graphics (work created by the new technologies themselves).

FMS and CIM concepts can have different configurations of machinery, work done and size. An FMS often means the integration of NCMTs and robotised transport and handling equipment, with labour savings which may plausibly range from a few jobs to dozens or hundreds of jobs. Even more significant labour savings can result from CIM configurations which involve computer control of the entire production process from design and manufacturing to quality assurance and product delivery. Both FMS and CIM concepts have evolved as pilot projects in Japan, the United States and some industrially advanced European countries. One study reports 50 FMSs in operation in the USSR in the mid-1980s and further plans to increase their number to around 1,800 in the near future.[10]

There is, however, much evidence of operational difficulties and even complete failures of both FMS and CIM projects.[11] It is pointless therefore to speculate on the employment effects of those integrated systems, although some studies have attempted to do so. For example, it is reported that in Germany (Democratic Republic) a prototype of a CIM plant has proved capable of reducing labour per unit of output by 300 per cent over that achieved by conventional methods.[12]

Sectoral trends in technological change and employment

Electrical machinery vs. overall engineering

Changes in labour productivity and employment can result from various factors, but the rate of technological change has clearly been the major factor in the engineering sector.

An examination of the database from the Economic Commission for Europe for 28 European countries and Canada, the United States and Japan shows that from 1980 to 1985 labour productivity in the engineering industry grew faster than in total manufacturing in most of those industrialised countries, including seven European centrally planned economies (omitting Albania and Yugoslavia).

Between 1980 and 1985 employment increased only in eight out of 21 countries in both total manufacturing and engineering for which data were available over the whole period. It is surprising that the two countries with the highest growth rates of employment were non-Eastern European countries: Japan and Cyprus. The case of Japan (with a steady 26 per cent increase from 1980 to 1985) is interesting since it has experienced a significant growth of labour productivity and very high levels of adoption of advanced machinery, yet the employment level in total manufacturing in the period remained virtually unchanged.

In electrical machinery, where advanced technology innovations have been more significant than in engineering as a whole, labour productivity rose more steeply than in total engineering in 12 out of the 18 countries with relevant data for the five-year period. Electrical machinery employment increased in 10 out of 19 countries. And even though labour productivity grew more in electrical machinery than in engineering, employment also grew more in the subsector than in the whole sector in all the 19 countries except the United Kingdom. The highest employment growth was in Bulgaria and Japan - respectively 33 and 31 per cent from 1980 to 1985, compared to 23 and 62 per cent gains in labour productivity.

What is most interesting about these comparisons is that employment growth performance has been better in engineering than in total manufacturing and still better in electrical machinery than in engineering. This suggests (for engineering and the electrical machinery subsector) a positive correlation between the general level of innovations and labour productivity and, surprisingly, between these two and employment.

Postal and telecommunications services

Recent technological changes in these services have had significant labour saving effects but these are not easily reflected in current employment levels. Some countries (Italy, Portugal, Spain, Switzerland) have experienced employment growth as a result of business expansion rather than of the work amplification effects of new technologies. Some examples of job reduction based on an ILO study are given below.[13]

In Belgium there was a decline of 3,000 telecommunications workers in 1985-90. In Germany (Democratic Republic) about 5,000 workstations were transformed by the automation and mechanisation of mail processing, 7,000 by the computerisation of administrative or accounting procedures and 5,000 by electronic switching techniques and optical fibre transmission. In Germany (Federal Republic) about 8,000 telephone network operators have been redeployed because of digitization, 6,000 workers have been retrained as a result of the computerisation of services, whereas 4,000 jobs in the mail service and 1,900 jobs in post-office counter services have been abolished. In Ireland there was a reduction of 4,000 jobs in the postal and telecommunications services between 1984 and 1989. In Hungary part-time jobs are expected to grow in the postal service in the early 1990s, but about 400 jobs are being abolished in rural areas as a result of automation. In Norway 420 postal service jobs were abolished in 1989 because of computerisation, although most of the employees affected were redeployed - partly because of the increased volume of work in other branches of activity. In the USSR mechanisation and automation of operations involved some job losses, despite a 14.5 per cent growth of the postal traffic and a twofold increase in the international traffic between 1986 and 1988. In Sweden there have been no reported dismissals but there is a freeze on recruitment. In Denmark, about 1,000 employees were recently transferred from the PTT administration to the telephone companies, although this was reportedly carried out without impairment of the rights of the workers.

Financial services

ILO studies and others have concluded that, by and large, the labour saving effects of microelectronics- and satellite-based technologies have not resulted in widespread job losses in banking and insurance. Advanced information technology has promoted profound changes in the profile of several operations and some occupations, slowing the demand for accountants, typists, receptionists and clerks engaged in routine information-handling while increasing the demand for programmers, systems engineers and other experts. There have been also changes in employment structure, job mobility and the types of services offered. In most cases where there have been cutbacks in the labour content of certain tasks employees have - at least until recently - been reabsorbed elsewhere in the enterprises to enable the expansion of business. Although there has not been widespread labour displacement in the sense of redundancies, employment has grown far less than output. In several European countries and North America computerisation has brought an increase in part-time work, particularly for cashiers and some routine operations where time savings have been significant. In most cases there have been significant staff increases in programming and systems engineering.

Most studies on the finance sector suggest that qualitative changes in employment have been far more significant than quantitative changes,[14] although these findings are expected to change with time as the efficiency of information and communications technology improves, partly as a result of changes in work organisation and further integration of client services.

Printing and publishing

A recent ILO study[15] reports that there has been net employment growth in this sector in most countries as a result of structural and technological changes, although it is difficult to disentangle the separate effects of these two types of change. Technological displacement of labour was evident in all the seven countries selected for in-depth analysis in that study and was concentrated in specific occupations. One of the compensations is that, in the commercial printing subsector, some microelectronics-based equipment has promoted small-firm growth which has boosted employment particularly in the so-called "quick printing" and "in-plant" printing segments of the industry. In some cases (most notably in the United States) the new technologies that are associated with colour reproduction have clearly created new jobs faster than they have displaced them. In Denmark, the United Kingdom and the United States the registered growth of employment in recent years has been caused by a combination of technological change, a general rise in demand, changes in company size partly related to technological change, and inter-sectoral adjustments.

As in other sectors the employment effects of technological changes will be evident only after many of the existing employees have retired and left the industry. This delayed effect stems from employment protection laws (e.g. in Yugoslavia) and co-operative employer-labour relations (e.g. in Japan).

In several countries there has been some considerable shift in the structure of printing and publishing employment, with a core-periphery pattern of work gradually emerging. This is caused primarily by seasonal fluctuations in demand, which have always been part of the industry, but also by new opportunities in work organisation made possible by some new technologies, the growth of small firms, shortages of skilled labour for some new specialisations, the deregulation of labour markets, and decreased levels of unionisation in the industry.

The peripheral employment includes unskilled and semi-skilled workers under temporary full-time jobs, as well as part-time and casual jobs. Most of these jobs are non-unionised, although this is far more evident in some countries (the United Kingdom, the United States) than in others (Denmark). The periphery also includes autonomous skilled workers who are paid less than the level stipulated by collective bargaining agreements. The key issue, however, is the varying degree of precariousness of employment and incomes in the periphery, and this variation may be explained by differences in the level of development of different countries, employment legislation, and the role of labour unions. The share of women in total jobs has generally increased, partly because of the loss of a significant number of traditionally male jobs and the growth of non-traditional printing but also because of a shift of production jobs to office jobs, including telephone advertising. The quality of many of these new jobs is lower than that of the jobs they replace.

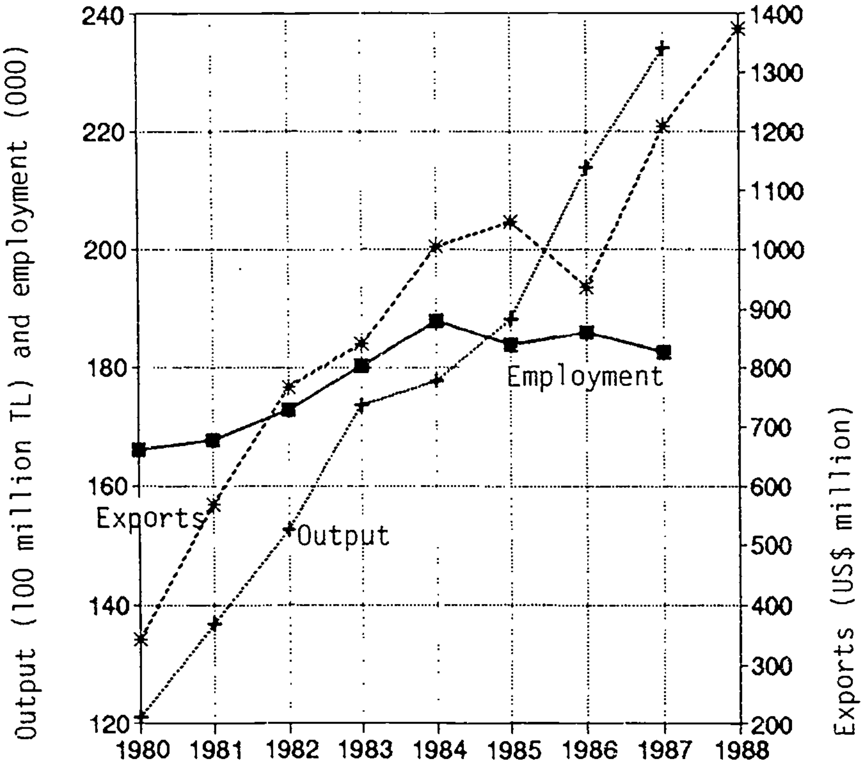
Textiles and clothing

The technological changes which have occurred in spinning and weaving have had very signicant labour-shedding effects, but have also brought positive changes in competitiveness. An ILO study of Turkey[16] shows very clear evidence of this. In 1984 Turkey had one of the lowest ranks in the rate of modernisation in spinning technology (i.e. shuttle and shuttleless looms) among OECD countries but this changed radically in 1984-87 as a result of heavy investment in response to deliberate government incentives to modernise. Fixed capital assets rose (in constant prices) by 22 per cent from 1983 to 1984 and 138 per cent in the following year. Textile machinery imports, reflecting new technology, were (in dollar terms) 47 per cent higher in 1984 than in 1983, and 3 and 39 per cent higher in the following two years in relation to the year before. The results of this are reflected in figure 1 which shows, after 1984, a two-year period of output adjustment, leading afterwards to a steep increase in output and exports but a reversal of the rising trend in employment which had occurred until 1984.

The same study suggests that few clothing firms in Turkey have begun to use microelectronic innovations, but the modernisation of the clothing industry has followed a trend similar to that of textiles: 144 per cent increase in fixed capital assets from 1984 to 1985. Clothing output and exports have grown tremendously but, unlike the situation in textiles, employment levels have grown as well, though a little less than output in value terms measured at constant prices.

For Italy's clothing industry, an ILO study[17] reports that most firms have introduced new technologies. Computerised accounting, invoicing and payrolls have been introduced in even the smallest clothing firms. In many cases CAD systems are used for decisions about product costing, cut-order planning and factory loading in multi-plant firms, while new telematic networks assist retailers with the preparation of sample collections, stock control and sourcing.[18] Computer-based real time systems which monitor work in progress and assist managers in production scheduling and line balancing are now installed in large firms. Most firms have altered their manufacturing methods in response to changing market trends, which require greater flexibility in the design and manufacture of a wide range of styles at low cost. Many have introduced computer-assisted systems for the pre-assembly stages of grading, layout planning and pattern modification and also for cutting. These changes have caused many medium-sized and large companies to close down, leading to a reduction in the average size of companies.

Figure 1. Output, exports and employment in the Turkish textile industry

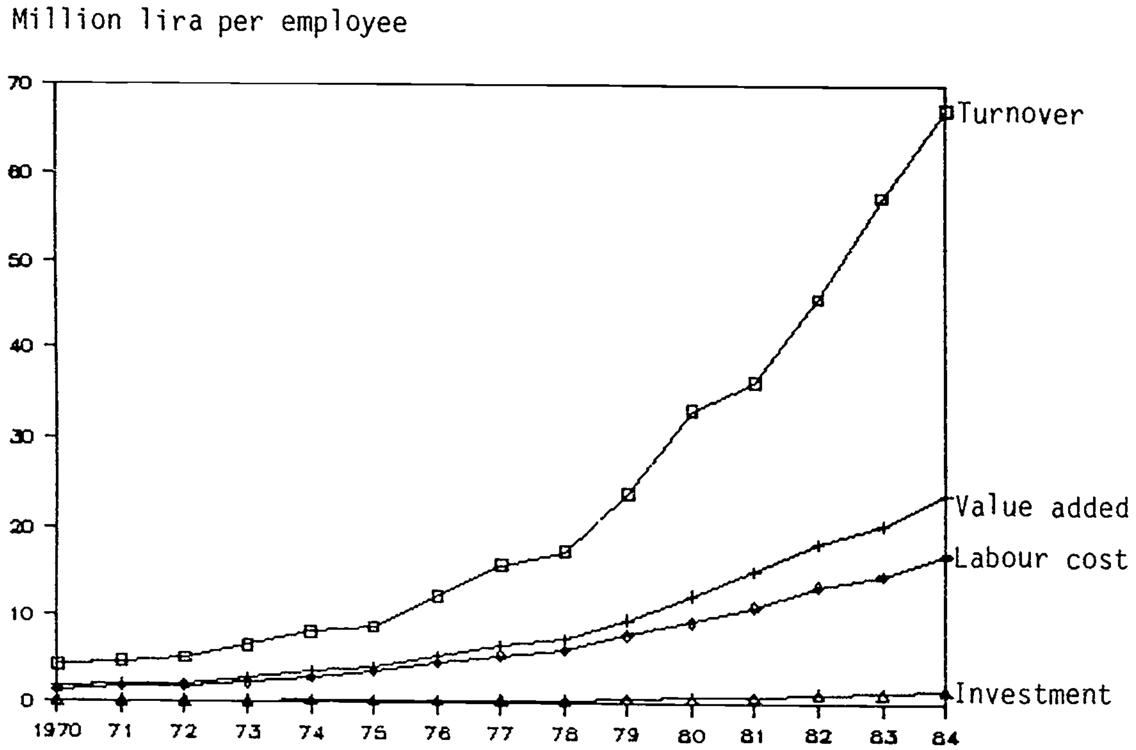


Source: State Statistical Institute: Annual manufacturing industry statistics (Ankara, various years).

As a result of these trends, production has been maintained at roughly the same level but exports have risen. Labour productivity increased while employment declined. Employment in Italy's textile, clothing and footwear industries decreased by 13 per cent between 1970 and 1984. Job losses in clothing were mainly in large firms and were due to the introduction of new technologies and to the relocation of the more labour-intensive production phases elsewhere. The number of self-employed remained stable, including irregular workers, artisans and homeworkers being subcontracted as needed. Many successful firms have relied to a significant extent on lower cost subcontracted work.

Figure 2 shows an overall favourable performance. From 1970 to 1984, there was an eightfold increase in investment per employee but a 16-fold increase in revenue per employee, while value added per employee grew more than thirteen times, more so than labour costs per worker. The still significant increase in labour costs per worker reflects, apart from inflation, a rise in the skill content of clothing manufacturing and associated increases in wages.

Figure 2. Index of performance indicators for the Italian clothing industry*



* Firms with more than 20 employees, average per employee.

Source: Elaborated from Istituto Nazionale di Statistica (ISTAT) data in G.F. Pent: Product differentiation and process innovation in the Italian clothing industry (Geneva, ILO; doc. WEP 2-46/WP.19).

Notes

1 K. Newton and N. Leckie: "Employment effects of technological change", in New Technology, Work and Employment (Oxford, Blackwell), Autumn 1987, p. 113.

2 See R. Kaplinsky: Micro-electronics and employment revisited: A review (Geneva, ILO, 1987), pp. 83-119; and K.H. Ebel: "The impact of industrial robots in the world of work", in International Labour Review (Geneva, ILO), Jan.-Feb. 1986, pp. 39-51.

3 C.M. Cooper and J.A. Clark: Employment, economics and technology: The impact of technological change on the labour market (Brighton, Wheatsheaf Books, 1982), p. 127.

4 ILO: The socio-economic impact of new technologies, Advisory Committee on Technology, First Session, Geneva, 1985.

5 B. Real: "Les puces et le chomage", in Le Monde, 24 Jan. 1989.

6 I. Christie, J. Northcott and A. Walling: Employment effects of new technology in manufacturing (London, Policy Studies Institute, 1990).

[7] R. Kaplinsky, op. cit., p. 86; and S. Watanabe (ed.): Micro-electronic, automation and employment in the automobile industry (Chichester, John Wiley and Sons, 1987).

[8] C. Edquist and S. Jacobsson: Flexible automation: The global diffusion of new technology in the engineering industry (Oxford, Blackwell, 1988), Appendix table 7.1, pp. 110-11.

[9] Arbeit and Arbeitsrecht (Berlin), 1986, No. 4, p. 79, and 1985, No. 6, p. 124.

[10] A. Samorodov: "Coping with the employment effects of restructuring in Eastern Europe", in International Labour Review, 1989, No. 3, p. 359.

[11] For a review, see respectively Edquist and Jacobsson, op cit., pp. 117-18, and K. Ebel: "Manning the unmanned factory", in International Labour Review, 1989, No. 5, pp. 531-51.

[12] Arbeit and Arbeitsrecht (Berlin), 1987, No. 9, p. 57.

[13] ILO: Technological change and workers' participation in posts and telecommunications services, Report II, Joint Committee for Postal and Telecommunications Services, Second Session, Geneva, 1991.

[14] For a review of ILO and other studies of industrialised countries see, for example, A. Rajan: Information technology in the finance sector: An international perspective (Geneva, ILO; doc. WEP 2-22/WP.210, July 1990.

[15] ILO: Security of employment and income in the light of structural and technological change in the printing and allied trades, having regard to other media, Report II, Third Tripartite Technical Meeting for the Printing and Allied Trades, Geneva, 1990.

[16] H. Ansal: The Turkish textile and clothing industry: Technological change, international competitiveness and employment (Geneva, ILO; doc. WEP 2-22/WP.212, Jan. 1991).

[17] G.F. Pent: Product differentiation and process innovation in the Italian clothing industry (Geneva, ILO: doc. WEP 2-46/WP.19).

[18] See K. Hoffman and H. Rush: Micro-electronics and clothing: The impact of technical change on a global industry (New York, Praeger, 1988).

CHAPTER II

EFFECTS OF TECHNOLOGICAL CHANGE ON OCCUPATIONAL STRUCTURE AND SKILLS

Advanced technologies have promoted changes in employment structure; not only has there been an increase in the share of workers with part-time and irregular jobs but considerable changes have also occurred in occupations and skills.

Earlier literature tended to emphasise the deskilling effect of microelectronics, but recent research provides limited supporting evidence. Deskilling has been observed in some occupations with a standardised job content (e.g. newspaper press operators, typesetters), and particularly in assembly lines and fixed automation systems, which are still widespread but are no longer a prototype of new technologies. Like several ILO studies, the PSI industry surveys referred to earlier revealed that deskilling occurs in some cases but that the need for new skills and greater flexibility are more typical consequences. NCMTs, for example, may in principle be operated by machinists with less qualification than was required for earlier machines. In practice, however, managers generally prefer to allocate highly qualified staff to work with NCMTs because they are much more expensive, more productive, more vulnerable to possible misuse, and more costly to keep idle in case of malfunction. In most situations the overall effect on skills depends on how the technology is used and how work is redesigned.

An ILO study[1] suggests that in extractive industries, in batch production and, to some extent, in agriculture, forestry and fisheries, there is a demand for higher skill levels to support increased automation in management and control and for more polyvalent skills for operation-cum-maintenance tasks. In process manufacturing microelectronics continues the long-term trend towards high capital intensity and dependence on high levels of skill to maintain operation. In mass production industries there is a falling demand for low-level and traditional skills but a rising demand for high-level and multiple skills. At the level of discrete stand-alone automation like CNC or low-cost CAD, existing skills can be enhanced after a learning period, and some scarce skills can be replaced by others. Skills for manipulating information systems have become a requirement for professional field work in such public services as health, welfare and education.

Microelectronics-based innovations increase the need for flexible skills and put a premium on skilled maintenance staff. Plant-level studies have shown that the more integrated and automated production is, the more important it is to prevent machines from breaking down and to repair them quickly to keep down time to a minimum.[2]

In financial services the share of computer specialists and other professional staff has increased sharply, although their overall number has remained small. The share of senior managers has risen in banking but not in insurance, probably because of the more diversified nature of banking services, but lower-level managerial staff have decreased significantly along with career clerks. The demand for junior managers has decreased because process innovations have reduced supervisory functions, although ILO studies suggest that the extent of the decline depends on whether the number of branch offices continues to expand or whether economic trends and organisational changes lead to fewer larger branches.[3] People who have acquired experience-based expertise in the course of their career have usually done so by dint of horizontal and vertical mobility; moving from traditional senior clerical functions to multi-task functions that have become essential for integrating computer specialists and other knowledge-based professionals. The share of career clerks has declined because of the partial automation of information handling and supervisory functions and their displacement by non-career clerks. The ILO studies provide evidence of several instances of job loading, where clerical and managerial work has been expanded to increase the number of functions performed under one job. Horizontal loading, involving the regrouping of unrelated tasks under one job, has been more evident in banking, whereas vertical loading, involving the regrouping of sequentially related tasks under one job, has been more evident in insurance. As a result, many clerical jobs have expanded their skill requirements. Managers have also undergone continuing re-skilling as they are increasingly expected to have expertise not only in management and finance but also in information technology, owing to its increased penetration in planning, marketing, general administration and in-house training.

In printing and publishing some occupations have completely disappeared while others, such as phototypesetting, have risen sharply as a result of new technologies. There has been an improvement in the general skill level but the effect on different occupations is mixed - some becoming more skilled through reskilling and multi-skilling and others less skilled.

In postal and telecommunications services, too, certain occupations are also disappearing and others are making their appearance, although not all of these are more skilled. Among the former are operators of manual telephone exchanges, the fitters and linesmen whose cable-laying and cable-connecting jobs are being superseded by electronic systems, the staff of telephone directory inquiry services which are affected by computerisation and the introduction of the electronic directory service, the workers in manual sorting stations, the typists, and the clerical employees whose daily jobs are increasingly performed by office machinery. Among rising occupations are computer and telecommunications engineers and other knowledge-based professionals and technicians, digital operators, and managers.

Notes

[1] J. Bessant: Micro-electronics and change at work (Geneva, ILO, 1989), pp. 41-47.

[2] ibid., p. 47. In the case of an FMS operated by Messerschmidt-Bolkow-Bluhm in West Germany involving 28 machining centres and a large number of ancillary machines, an analysis of down time over a total period of 6,000 hours, for 24 of the machines which had been running continuously over three shifts, revealed that 56 per cent of the stoppages were caused by an unexpected fault requiring repairs.

[3] See A. Rajan: Information technology in the finance sector: An international perspective (Geneva, ILO; doc. WEP 2-22/WP.210, July 1990); and L. Mertens and A.F. Pereira: New information technologies and employment in financial services in Mexico (Geneva, ILO; doc. WEP 2-22/WP.219, forthcoming).

CHAPTER III

COPING WITH THE EMPLOYMENT EFFECTS OF TECHNOLOGICAL CHANGE

How has technological change been managed at the firm level? What measures may be taken by tripartite decision to alleviate some of the negative short-term effects on employment structure and job security, to improve job mobility for redundant workers, and to cope with a rise in skill requirements?

In some industries, banking, insurance and public services, managers have approached advanced technology as a means of enhancing competitiveness and boosting productivity without expanding their workforces. In other cases (e.g. textiles, pulp and paper, newspapers, steel, automobiles, metal and mechanical products) job redundancy has been unavoidable but has often been alleviated in the short term by three major factors. First, the overall rate of technological change in the 1980s has been slower than had been generally expected in the late 1970s, and new technologies have in most cases been introduced gradually, thus spreading their labour-shedding effects over long periods. Second, in the majority of cases job reduction has been involved mainly in the form of natural wastage and voluntary rather than compulsory redundancy. In addition, redeployment measures combined with retraining have had some success in minimising job losses.

Firm-level analysis further reveals that the actual effect of technological change and resulting rationalisation and reorganisation on existing workers can vary significantly from one firm to another in the same sector owing to differences in organisational development strategies, in employers' attitudes to training, and in both the extent and the design of retraining programmes. This is a key finding for identifying and negotiating alternative measures for coping at least with the short-term labour effects of change. Unions and governments can also play an important role through unilateral policies and especially tripartite arrangements. These different issues are analysed in subsections below.

An additional and most critical question needs to be highlighted, although it cannot be adequately treated in this limited discussion: what can be done to cope with the probability that, in the long term, net employment growth may come short of labour force growth in some industrialised countries? This question is raised by the data in table 3. According to additional data (not shown in the table), the growth of the working-age population is projected to fall in eight out of 24 OECD countries from the late 1980s to the year 2000. This may continue to alleviate the problems of unemployment, as shown for 1990-91 in figure 3, but it cannot cut unemployment rates significantly. This is suggested by the fact that output is growing more than employment in most sectors, that recruitment rates have sharply declined in some major sectors, and that the labour-shedding effects of new technology and related organisational adjustments will be increasingly evident as current workforces retire and new technologies are made more efficient through additional reorganisation of work and increased globalisation of industries and services. Even in countries where technological change will have significant positive indirect effects on employment, the combined long-term effects of structural, technological and organisational changes are likely to cause employment to grow at lower rates than the number of people looking for jobs as a source of income. Possible exceptions may well be the few major technology supplying countries with strong employment growth not only in the production of new machinery but also in related R&D, adaptation, marketing and servicing. These arguments are none the less of a speculative nature as current research and statistics are inconclusive about future trends.

Table 3. OECD economic indicators

	1979-87	1988	1989	1990	1991
OECD TOTAL					
GDP growth rate	2.5	4.4	3.6	2.9	2.9
Employment growth rate	0.9	1.9	1.8	1.2	1.1
Labour force growth rate	1.2	1.3	1.3	1.2	1.1
Unemployment	7.3	6.9	6.4	6.4	6.5
OECD EUROPE					
GDP growth rate	1.9	3.8	3.5	2.9	2.8
Employment growth rate	0.3	1.6	1.4	1	0.8
Labour force growth rate	0.9	1	0.7	1	0.8
Unemployment	8.7	9.2	8.6	8.6	8.5

	1981-83	1983-85	1986	1987	1988
OECD TOTAL					
Employment growth rate	0.1	1.4	1.6	1.8	1.9
Full-time employment growth rate	-0.5	1.5	1.3	1.5	1.9
Part-time employment growth rate	3.4	1.8	2.5	2.3	2.3

Source: Based on various tables in OECD: Employment Outlook, 1990; and OECD, Historical indicators, 1988.

Figure 3. OECD Europe: Annual growth rates of GDP, employment, labour force, and unemployment

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Redeployment and related measures at firm level

Redeployment has been the most common means adopted by firms for preventing the dismissal of workers, but this has varied considerably with the extent of technological change, the rate of business growth, the level of job protection legislation, and adjustments in hours of work. For example, in the printing and publishing industry the radical and fast changes in technology in newspapers during the 1970s led to levels of labour redundancy which could not be successfully coped with simply by redeployment measures. In contrast, a more gradual wave of technological change in commercial printing has shed labour, particularly in large traditional firms, but has at the same time expanded the growth of new business and related employment.

In the finance sector job losses due to the introduction of new technology have been prevented mainly by redeployment to cope with business growth, including new services. In numerous cases, particularly in banking and life insurance, early retirement and unfilled vacancies have been widely used to adjust manpower to the volume of business some time after the new technology has been introduced.

In postal and telecommunications services a large number of the workers affected by new technologies have not been dismissed because of redeployment measures, business growth and employment policies, including employment protection schemes - especially in the public sector. The effects of technology are being reflected in declining recruitment rates, whereas significant changes in employment can be expected later as the current workforce gradually retires. At present, the most acute problem in the postal and telecommunications services is probably not employment but rather the development of skills, jobs and careers.

The experience of the postal and telecommunications sector illustrates the close relationship between job protection and redeployment. Although changes in technology have been similar in many countries, there is a very clear split between countries where redundancies have led to dismissals and countries where this has not happened. In Iceland, for instance, the Government does not recognise the right to job security; where an employee is affected by the abolition of a job (e.g. telephone operators) and cannot be redeployed, he or she receives a redundancy benefit not exceeding 12 months' wages. In Turkey some workers have been re-employed and in the interim are on leave without pay. However, in most Eastern European countries, Denmark, Finland, Germany, Greece, Malta, the Netherlands, Portugal, Spain and Sweden, security of employment is guaranteed by the public service status, by collective agreement or, in practice, by the development of other sectors of activity. In all these cases, redeployment measures have been adopted together with retraining. In some cases, redeployment policy has required secondary measures. For example, in Sweden redeployment pressure has been eased by a freeze on recruitment. In the United Kingdom and the United States there has not been compulsory redeployment, but it has been promoted by other measures such as early retirement. In the United States redeployment of staff has been of limited scope because the job losses due to deregulation (e.g. 100,000 jobs lost with the break-up of ATT in 1984) have been offset by the growth of demand for services and by the new jobs created by increased automation.

Redeployment has also been made possible by changes in working time. In Western Europe hours of work have often been reduced to prevent dismissals. In Eastern Europe, however, redeployment has been facilitated by the fact that many enterprises have been operating, in the Soviet Union in particular, on a one-shift basis.[1] By introducing multi-shift work, localised employment problems have been alleviated while promoting a fuller use of existing capacity.

Labour flexibility

Another way firms have prevented dismissals due to technological change has been by making their existing workforces more flexible in terms not only of hours of work but also of job content, earnings and fringe benefits, and the use of skills. The various forms of labour flexibility have their advantages and disadvantages, and these need to be distinguished in the light of prevailing socio-economic conditions.

The changes in demand and technology which have characterised some sectors make it desirable for firms to develop flexibility of production in two ways: by adjusting employment to changes in the level of production in response to changes in the level of demand, and by adjusting production to meet qualitative changes in demand. Advanced technology is promoting these management strategies in some sectors by permitting adjustable changes in scale and composition of output.

In the first case, a "numerical" flexibility in employment means that, when demand expands, a core workforce can be supplemented by a more transitory workforce, normally but not necessarily with a lower level of skills. In the second case, a "functional" flexibility means that the employees can perform different tasks, according to changes in the composition of demand.[2]

These two types of flexibility have important repercussions for job and income security and for skills and training; they also affect the nature of employer-labour relations and the role of labour unions.[3]

Numerical flexibility and work-time flexibility - jointly referred to here as employment flexibility - have become increasingly common in several industries as a combination of measures aimed at safeguarding the prosperity of firms and minimising job losses caused by the contraction or fluctuation of demand and the adoption of advanced technologies. The extent of this flexibility varies significantly from one country and sector to another, but it appears to be more evident in sectors faced with seasonal and fashion-related fluctuations in demand, such as printing and publishing, paper, clothing, footwear, and in sectors where certain stand-alone operations can be done outside the main work place with little or no integration with other operations.

Employment flexibility is conducive to increased job security for the core workforce and relative instability for the pool of transitory or stand-by workers. This core-periphery pattern of employment appears to clash - at least partially - with the objective of job security for the overall workforce; and it may or may not be acceptable in a specific country depending on the characteristics of the peripheral employment, particularly its relative precariousness. However, the level of job insecurity at the periphery depends on the growth rate of output of the industry, the deficit or shortage of skilled labour, and the management of skills.

Efforts by firms to attain functional flexibility generally include an increase in the responsibility and skills of their core workers. In some cases this involves a vertical integration of skills, with workers undertaking tasks requiring higher competence which were previously done by specialised, more skilled workers. This is sometimes the case of multi-skilled machine operators. More common, however, has been a horizontal integration of skills, involving tasks at similar levels of competence.[4] This horizontal and vertical integration of functions (discussed in Part 2) promotes greater job security for the workers involved, simply because they become more indispensable to the firms. Incomes improve as well. For example, in Denmark's printing and publishing industry a growing number of companies have offered salaried jobs to skilled wage-earners as a means of retaining a core workforce with essential skills.

Flexibility vs. security of employment:
Striking a balance

There is no argument against the advantages of functional flexibility, but the various forms of employment flexibility do call for a more critical approach.

While promoting greater job security for the core workforce, the pursuit of employment flexibility by enterprise managers may, in certain countries, require innovative measures to minimise unfair employment practices, irregularities and related problems. Besides redeployment, other measures which may be suitable for collective negotiation and have been tried in some countries include: voluntary job sharing during adjustment periods and part-time work; early retirement; and the participation of the workforce in the gains and temporary losses of production, possibly including temporary reduction of fringe benefits and, in very critical situations, of income benefits.

Flexible work time, including shift work and weekend work, has always been a part of most industries, and traditionally there has been a trade-off between flexible working hours and wage compensation which is reflected in relatively favourable overtime earnings. However, high investment in new technology has in some cases increased the pressure on workers to accept excessive shift work, and in some countries this has resulted in confrontation. For example, in Denmark some such disputes in the printing industry have had to be resolved by arbitration, the outcome of which has usually underlined the employers' unambiguous right to control and distribute the work - but within certain limits (e.g. a minimum of seven hours of work per day and a maximum of 11) and within the constraints placed upon them by labour laws and general collective bargaining agreements.

Part-time employment plays an increasingly important role in overall employment in several OECD countries (see table 2) and has significantly alleviated unemployment. For many jobseekers, particularly women and youngsters, it offers the possibility of reconciling work with family life and education and of promoting job satisfaction. These considerations often encourage part-time employment. In most countries, however, it implies a certain precariousness as part-time workers are not eligible for unemployment compensation or for special training and retraining programmes. Furthermore, part-time work should be clearly differentiated from casual or temporary work or other precarious working arrangements, which in some countries may not be protected by minimum-wage legislation or provide any of the social and fringe benefits that even part-time jobs may offer.

Enhanced flexibility in working time is normally expected to be compensated by improved earnings, fringe benefits or other tangible gains in job security. Measures which reduce financial benefits may be adequate only for very short periods and evidently cannot be effective in the long run. Even for very short periods, the feasibility of reduced hours of work with corresponding pay cuts depends on the readiness of workers to make income sacrifices. If workers participate in profit-sharing schemes, they are much more likely to sacrifice income in times of adjustment than are workers without such benefits.

Sharing the cost of the adjustment to technological change

Through tripartite negotiation firms can be and often have been asked to carry extra workers to ease the transition to new technology. But this implies reduced profits for reinvestment and related productive employment elsewhere. Some would ask whether it is right that progressive firms should pay the penalty of retaining or absorbing workers displaced by technical progress? Others would contest the notion of progress as a rigid inevitable process, and would ask whether it is politically feasible and desirable to transfer the cost of redundancy to firms which either cause redundancy and/or have favourable financial conditions to help absorb that cost. Certainly, to some firms the extra cost may lead to bankruptcy or failure to adopt an otherwise desirable innovation. But the proposition of making financially successful firms bear a large part of the cost of redundancy may be in some cases a better option for the economy and for society than higher taxes (to pay for unemployment compensation) or simply a deterioration of income for the redundant workers.

If firms cannot or should not be expected to deal alone with problems of redundancy, redeployment and reskilling, the adjustment surely has to be shared by employers, governments and labour unions. Under a framework of tripartite relations, several questions thus emerge about the prospects for promoting security of employment and incomes, of upgrading the level of skills, and of improving job mobility for workers made redundant by technological change who cannot be redeployed in the same firms or find suitable jobs in other firms. These questions are raised in the concluding section.

Collective agreements and legislation on technological change and security of employment

Employment security - as a concept and as a social objective - is accorded varying importance in different countries, depending primarily on the existence and effectiveness of social security schemes and the general level of incomes. In most countries, however, it remains a central theme of economic restructuring and technological change in various sectors.

The means of promoting employment security and their respective advantages and disadvantages for the workers, the firms and the national economy are a controversial subject.[5] This debate is not repeated here, but it is important to review some of the key issues in the light of country experiences.

Legislation or collective agreements that protect workers from loss of employment caused by the introduction of new technology have obvious advantages (at least in the short term) for the workers involved. Such measures tend to be perceived as a disadvantage by employers, but this perception is not always well founded. One study[6] has presented statistics which suggest that countries with high rates of labour turnover are among those with low productivity growth. Employment security can have benefits for both workers and employers, including worker motivation and commitment, acceptance of productivity-raising measures and willingness of workers to accept greater flexibility in job content, hours of work, earnings and other conditions. Depending on the extent of these benefits, employment security measures may have the disadvantage of sacrificing efficiency, which may or may not critically affect competitiveness. From the perspective of the whole economy, another likely disadvantage of job protecion is that it can accelerate the adoption rate of new technology to a level which may not be optimal for firms and for the economy in the short run, while aggravating employment problems in the long run. It can, in some conditions, protect existing workers by reducing employment opportunities in the future.

Some countries, such as Yugoslavia, have specific legislation aimed at granting workers security of employment; in some cases, it makes specific reference to the effects of technological change. In Finland the 1987 Employment Act established that the authorities are obliged to find youths and the long-term unemployed either employment or a training place. In Canada, the Federal Government and the provinces of British Columbia, Saskatchewan and Manitoba have amended their labour legislation to require collective bargaining on technological change. In Sweden, employment is extensively regulated. As noted in an ILO study, "employment security is protected, but the design and application of the ... laws allow for considerable variation of decentralised interpretation, putting constraints on dismissals while encouraging a more orderly process that tends to reduce the personal and social costs of redundancy and making it more advantageous to seek alternative means of redeploying workers without unemployment."[7] Workers are protected against unfair dismissal and have to be given considerable notice of dismissal in the case of lack of work.

Some countries have technology agreements at the national, regional, sectoral and plant level which seek to determine the workers' influence on technology decisions and/or security of employment. Most of these agreements emerged from labour union pressure, first in Scandinavian countries, the United Kingdom and Germany but later also in France, the Netherlands and Belgium. Their effectiveness has not always been clear, however. For example, the Belgian technology agreement of December 1983 has been analysed in a large-scale survey covering nine companies and involving 2,000 questionnaires, 25 per cent of which were answered. The authors concluded that the agreement had very limited success however.[8] This conclusion and those of other studies[9] suggest that national-level agreements on technology have some important limitations, and that they are generally less effective than plant-level agreements in terms of workers' influence on actual decisions on technology, although they can be quite effective in providing a positive framework for continued negotiation.

Aims of training policies and programmes

Training programmes need to be designed for several purposes and targetted at different segments of the workforce: to meet the skill needs of new and growing occupations; to enhance the skills of existing workers to cope with incremental changes in equipment, job specifications and work organisation; to provide multiple skills for existing workers to improve their functional flexibility. These fairly conventional types of training have to be supplemented by special training efforts for retraining staff whose jobs have been abolished or redesigned. In addition, more comprehensive programmes have to be designed or improved to promote labour-market adjustment and the mobility of workers affected by those changes or by physical and mental disabilities. These broader programmes - which normally include the more conventional types of training - have in fact been developed in some European countries to enhance job mobility for workers unemployed or threatened by unemployment, for those for whom new or supplementary training is needed to sustain or enhance skills, and for those needing training to enable them to move into occupations for which there is a major labour shortage. While helping to alleviate unemployment problems, these programmes also aim at promoting social equity while stimulating economic growth. They have been targetted primarily at young workers above the normal age for vocational training but also at older workers who have been made redundant or have difficulty in finding new jobs.

Notes

[1] A. Samorodov: "Coping with the employment effects of restructuring in Eastern Europe", in International Labour Review, 1989, No. 3, p. 360.

[2] See A.J. Phillimore: "Flexible specialisation, work organisation and skills: Approaching the 'second industrial divide'", in New Technology, Work and Employment (Oxford, Blackwell), Autumn 1989, pp. 79-91; and A. Pollert: "The 'flexible firm': Fixation or fact?", in Work, Employment and Society, Sep. 1988, pp. 281-316.

[3] See, for example, D. Cornfield (ed.): Workers, managers and technological change: Emerging patterns of relations (New York, Plenum Press, 1987); and E.M. Kassalow: "Concession bargaining: Towards new roles for American unions and managers", in International Labour Review, 1988, No. 5, pp. 573-592.

[4] Phillimore, op. cit., p. 87.

[5] See M.J. Piore and C.F. Sabel: Second industrial divide: Possibilities for prosperity (New York, Basic Books, 1984); and G. Standing: "Labour flexibility and older worker marginalisation: The need for a new strategy", in International Labour Review (Geneva, ILO), May-June 1986, pp. 329-348.

[6] G. Rehn: Cooperation between the Government and workers' and employers' organisations on labour market policy in Sweden (Stockholm, Swedish Institute, 1984), p. 10.

[7] G. Standing: Unemployment and labour market flexibility: Sweden (Geneva, ILO, 1988), pp. 75-77, 93-94.

[8] M. Albertijn, B. Hancké and D. Wijgaerts: "Technology agreements and industrial relations in Belgium", in New Technology, Work and Employment, Spring, 1990, pp. 26-29.

[9] See R. Williams and F. Steward: "Technology agreements in Great Britain: A survey 1977-83", in Industrial Relations Journal, Vol. 16, No. 3, 1985, pp. 58-73.

PART 2

TRAINING FOR NEW TECHNOLOGY

INTRODUCTION

Today the major education and training issue is: How do we prepare workers for rapid change in technology and work organisation? Much research has been conducted by the ILO and other institutions into the profile of the workers, technicians and managers who are working with new technologies, and we now have a fairly good picture of the skills, knowledge and behavioural attributes that innovating companies demand from their staff. But we know much less about how to generate the profiles and human qualities that have become the primary objective of training. The purpose of Part 2 of this report is to explore some recent training innovations, schemes and methods for new technology which are likely to be effective in attaining these objectives.

It has become increasingly clear that conventional education and training systems do not meet the needs of the economies and firms that are increasingly resorting to new technologies. Traditionally there have been two major types of training: school-based training and enterprise-based training. Both have strong and weak points.

School-based education and training is thought to have a comparative advantage in teaching theory and the fundamentals of a discipline, while training in firms is supposedly strong in developing work-related, specialised skills. But in a time of rapid technological change both have often failed to produce the skilled workers that are needed to fit the new work demands.

Lacking the necessary links with industry, schools often fail to target their work-related training. They train for skills that are not in demand. Attempts to innovate are often hindered by a slow-moving bureaucracy. Schools with an academic tradition tend to emphasise theory at the expense of practical, hands-on experience, while those with a more practical bent often lack the resources and status to attract good students and teachers.

Notwithstanding its close affinity to company needs, in-house training has its own shortcomings. Although a few countries can boast successful company-based training programmes, elsewhere this is far from being the case. Many firms are unwilling to train because they fear poaching by other firms, the only apparent answer being to develop a corporate culture wherein the staff identifies with the firm's objectives. The lack of financial and other incentives is another reason why there is so little in-house training. Without some form of grant or training tax out of which training expenses can be reimbursed, firms often have no interest in training and upgrading their staff. Not infrequently, managers simply do not perceive training as an investment which will pay an economic dividend but consider it a burden on the company. Training is an expensive and time-consuming activity and small firms especially often lack the necessary resources. The dearth of training materials and programmes that are suited to small firms' particular skill development needs adds to their reluctance to engage in training.

The chapters that follow explore some recent training programmes and schemes which endeavour to combine the best features of school-based and company-based training by means of various innovative forms of programme design, organisation and financing.

CHAPTER IV

TRAINING FOR NEW TECHNOLOGY: THE ISSUES

With the advent of the third industrial revolution, industry's attitude to training has been affected by the following developments:

- Large companies have become even larger and increasingly internationalised.

- An increasing number of small and medium-sized firms are engaged in innovation and technological advance, while much manufacture is contracted out by larger firms to smaller ones, sometimes internationally; subcontractors must consequently adhere to the clients' quality standards.

- Government agencies often subsidise the training needed by smaller and medium-sized firms; increasingly complex funding arrangements have appeared, examples being the Steinbeis Foundation of Baden-Württemberg, Germany, and the United Kingdom's Teaching Company Scheme.

- The increased ratio of "white-collar" to "blue-collar" workers is accompanied by an intensive search for particular talents and skills.

- Large and some medium-sized companies are stepping up their support to educational institutions.

- Large corporations invest heavily in training and create multi-faceted educational establishments; a typical case is the "Motorola University.

- Some educational institutions are entering the business world with well-designed products, while putting a premium on "hands-on" training. An excellent recent example is the Ecole St. Croix in Switzerland; Loughborough University of Technology in the United Kingdom is another that dates back to the 1930s.

- "Science parks" and similar initiatives are very useful for small technology-based companies.

- Technology transfer among rich countries usually requires special training facilities at several levels. A good example is the manufacture of Japanese cars, and cathode ray tubes in the United Kingdom. "New" technological methods, different management systems and changes in traditional cultural attitudes to work are all elements of the training that accompanies such technology transfer.

Most of the world's industrialised societies possess some special features of training that could be adapted to other countries. Germany, for example, is often cited for its combination of a successful economy and an efficient education and training system (though, as elsewhere, German industrialists complain that the system is not suited to their "needs".)

The United Kingdom's National Institute of Economic and Social Research (NIESR), which recently compared the training performance of France, Germany, Japan and the United Kingdom, brought to light marked differences in national attitudes to training. It reached the tentative conclusion that broad-based training schemes yield a significant advantage when technology is changing quickly since, in addition to providing know-how, they encourage adaptability in the workplace.

The symbiosis between education and training systems has clearly become more complex with the passage of time. Although large corporations can be self-sustaining in vocational, continuing and remedial training, an adequate basic education remains an absolute prerequisite.

Two notably buoyant economies, those of Germany and Japan, operate well-structured education systems catering for different academic capabilities. Each has large vocational facilities, the difference between the two being that those of Japan are primarily provided by the corporate sector. In both countries it is claimed that specific training operations are most successful when based on broad but relevant background education, and that this disciplined approach has particular merit where the focus is on adaptability to change. Other societies, with different cultures, view the situation differently. The United States, for example, places great emphasis on the responsibility of industry itself to motivate employees to adjust to change and relies less on the broad educational approach.[1]

Training under conditions of change and uncertainty

New technology has elusive frontiers and its own dynamics. In particular, modern manufacturing and processing industries have changed beyond comparison with their predecessors, and the rate of change is accelerating.

With such a changing scenario, trainers and training managers face formidable, and expensive, training problems. Since the companies are dealing not with generalities but with the health of their products and product lines, the cutting edge of training lies with them and not with governments and their agencies. But, for cost and other reasons, companies tend to use whatever is available from the vast - and publicly funded - education systems. This has to be done selectively since academic training does not usually immerse the individual in the technology, organisation and human relations of industry. Hands-on education may be regarded as the individual's most formative path towards "questioning insight".

In a rapidly changing technological environment, it is particularly important that industry sustain and extend training by means of "in-house" arrangements. Education programmes are needed which realign human attitudes towards the integrated processes of manufacturing. The contribution of academic staff and facilities to company "in-house" training and of industry staff to academic courses and research is growing. Recently, large industrial corporations have established their own private universities.

Industrial support for academically placed research is of long standing, but the appearance of this "mutual advantage" relationship is new. (Chapter VII discusses how the gap between industry and publicly funded, higher education institutions is narrowing.) Such links may entail trainees gaining experience through involvement in industrial operations or R&D, government assistance to small and medium-sized industry, the creation of new products and processes, enhanced use of the facilities of the formal education system, mutual interaction between industrial and academic staff, and direct contributions by industry to the academic establishments.

This does not mean the demise of traditional training methods, such as apprenticeship schemes, sandwich courses and project work in engineering and applied science at the university level. They are likely to change, however, as they make increasing use of new, sometimes revolutionary, tools. This is discussed in the following chapter.

Note

[1] See G. Kanawaty: "Training for a changing world: Some general reflections", in International Labour Review July-Aug. 1985, pp. 401-409; and Torkel Alfthan: The skill and training implications of new technologies (Geneva, ILO; doc. F/POL/DP/10, May 1985).

CHAPTER V

COMBINING SCHOOL-BASED PROGRAMMES WITH HANDS-ON TRAINING

If a single feature can be identified as characterising the most effective training for new technology, it is the practical, or "hands-on" component. It is vital at the strictly vocational level, since skills cannot be acquired without practice. It remains true also at the professional levels, and when the skills required are managerial and depend on lateral thinking.

For over 25 years R.W. Revans has been advocating what he describes as "action learning".[1] Commenting on this important development,[2] Jones speaks of:

> ... two major themes in man's attempt to cope with the changing world. One says that man must rely on experts and book learning. The other says that we must place our confidence in the lived experience and insights of those who act; farmers, miners, nurses and managers. Action learning ... was evolved by Revans from his conviction that it is the latter view which must prevail if we are to cope with accelerating and turbulent change.

Action learning gives ample recognition to the role of the teacher in enabling the pupil to acquire "programmed learning", but the crucial element required to cope with change is "questioning insight", which is precisely the quality that distinguishes effective training.

Apprenticeship

The long period of training for a particular trade at very low wages, which was so common a hundred years ago, has now been replaced by wider skill training combined with longer full-time and part-time attendance at school. Those who finish their apprenticeship training today are potentially much more mobile than their predecessors in their search for advancement and better job prospects.

Germany has a highly organised system in which much of the responsibility for apprenticeships rests with industrial management and the trade unions. Apprenticeship schemes are regulated by law and each Länder establishes its educational facilities. Germany boasts a highly competitive industry within a successful economy, on the one hand, and an adequate supply of trained craftsmen, on the other.

France inclines towards this system, but less so. In France an apprenticeship contract is signed at the minimum age of 16 years for two years, after which the apprentices normally receive a diploma (certificat d'aptitude professionnelle). French apprentices searching for new job opportunities are reputed to be very mobile.

In the United States apprenticeships in manufacturing are predominantly in maintenance departments, a significant development in view of the enhanced role of maintenance in automated and robot-equipped industries. To be registered with a state agency, apprenticeships must provide a minimum of 144 hours of off-the-job training per year.

<u>Project work and its relevance to industry</u>

Project work is commonplace in institutions teaching engineering, applied science and technology. Austria and Germany have always placed great emphasis on project work, whereby students acquire both practical experience and familiarity with the industrial environment. Though acclaimed in many parts of the world, the system is nevertheless criticised by German industrialists as not being sufficiently industry-oriented. The same criticism is often voiced in other industrialised countries, and it is difficult to ascertain to what extent it is founded. The most common complaint is that what the students are taught is often far removed from what industry actually needs. To meet this challenge there is now far more cooperation than in the past between industry and educational establishments, moreover, this cooperation extends beyond large industrial enterprises to include medium-sized and, in certain conditions, small companies.

The flaws that come to light in such projects have been receiving attention in all countries, in order to develop precisely the kind of qualities that are not tested through the examination system. Although the tangible results of formal training can be measured in terms of the exercise of logic, knowledge of the syllabus, analytical skill, self-expression, etc., it is a person's "hands-on" experience, ability to design experiments or artefacts and to appraise results, inventiveness, and such like that should be the hallmark of a successful project, whether or not it be industry-based.

An award-winning project scheme developed at the Polytechnic of Huddersfield in the United Kingdom illustrates what can be attained even through relatively short courses (three years for full-time, and four years for sandwich courses). These courses are claimed to be cost-effective and permit young people to start earning their living by the time they are 22 years old. In the first year, after acquiring some elementary freehand and engineering drawing skills, the student engages in a "Dismantle, measure, draw and rebuild" exercise. Each student makes drawings and produces a report specifying tolerances of components, surface finishes, materials, etc. After assembly, the casing of the device (gear pump, hydraulic cylinder, bevel gearbox, etc.) is machined to allow observation of its workings and will, in later years, be used as a teaching aid. The second project of the first year is called "Design and make". Groups of four students make a relatively simple device to a fixed budget, with a viable set of manufacturing drawings and a parts list. Three design projects are undertaken in the second year of the course. The first encourages solutions to be proposed from a variety of engineering disciplines; the second is concerned with aesthetic and ergonomic design; the third project concentrates on design analysis, including the use of computer software packages, and involves computed-aided draughtsmanship techniques. In the final year, there are two group projects. The first concentrates on mathematical modelling, consequential prediction and experimental confirmation. Computer-aided design (CAD) may be used for the model, and computed-aided manufacture (CAM) employed for producing the prototype. Individual student projects follow, based on proposals from the firm where the student has been "placed". This last project must be concluded within a strict time schedule and yet allow a broad range of engineering disciplines to be employed. Constraints of cost, feasibility and customer satisfaction must be observed. The active cooperation of industry is essential for the success of this kind of "hands-on" scheme. The success of this particular course in mechanical engineering design should not be allowed to overshadow other projects that could be designed to meet other "needs" of industry than designers of products and plant.

Academics often claim that many projects are significantly in advance of what industry can assimilate. They argue that universities' main task is to explore and test the leading edge of technology. Though not conducive to cooperation with industry, this view does bear examination.

The multiplicity of tasks within the world of manufacturing does not lend itself to easy generalisations. Civil engineering, for example, is ill suited to the project approach: chemical engineering processes are intimately concerned with control engineering; the energy industries make oil, gas, electricity and coal available, not products. The difficulty of formulating realistic projects has encouraged the manufacturing and service industries to collaborate more closely with training institutions. A long-established form of such cooperation is the "sandwich" course.

"Sandwich" courses

The singular advantage of the sandwich course is its close association with industrial practice. The sandwich (or "cooperative") course was the earliest systematic form of close and regular cooperation between teaching institutions and industry.

Since the beginning of the century, sandwich courses have changed in their structure, content and industrial alliances. When first organised, they were limited to large companies, all belonging to the heavy "smokestack" industry, then the firm backbone of manufacturing. The advantages to the companies were evident. Industry did not have to employ trainees after graduation, but were able to select from the pool of trainees those who had shown ability and aptitude. Students also benefited by gaining an insight into the workings of an industry. Today, sandwich courses play an important role in introducing trainees to new technology. Although the courses have evolved over time, they have retained their original advantage in providing access, under conditions of rapid technological change, to a regular supply of young talent with "hands-on" experience.

A typical sandwich course consists of two academic years, during which laboratory work receives high priority, followed by one year in industry and a final year in which the experience accumulated during the course is used in collaboration with industry. The objectives of the course are to enable the students to apply the theoretical and practical experience gained during the first two years of the course, to extend their understanding of relevant engineering systems and associated principles and techniques, to experience the general operation and standard practices of industrial organisations, to gain human experience through working with staff from their own and other fields, to acquire a sense of responsibility when working alone and as a member of a team, and to appreciate the importance of project management.

At the Polytechnic of Huddersfield in the United Kingdom, for example, sandwich courses are available in mechanical and production engineering, control and systems engineering, computing and information technology, chemistry and chemical technology, chemical engineering and industrial biochemistry. By way of illustration, the four-year course in computer-aided engineering covers the following topics: first year - mathematics, mechanical sciences, electrical and electronic sciences, computer studies, experimental methods, manufacture and materials, industrial studies, engineering design and workshop programme; second year - mathematics, computing and computer systems, computer-aided design and manufacture, manufacturing systems hardware, mechanical sciences engineering design (CAD), manufacturing organisation and management, the enterprise and the engineer (group project); third year - supervised industrial-training period (38 weeks minimum); fourth year - computer-aided manufacturing systems, computer-aided design and analysis, computers in automation and computer-aided production management and project.

Both the students and the industrialists benefit from the sandwich courses. For the latter the course puts them in touch with young, aspiring recruits who have had an organised introduction to industrial work and procedures. For the former it is an opportunity to become familiar with "new" technology and attain positions of responsibility more quickly.

Notes

[1] R.W. Revans: *Action learning: New techniques for management* (London, Blond and Briggs, 1980); and *The origins and growth of action learning* (London, Chartwell Bratt, 1984).

[2] M.L. Jones: "Action learning as a new idea", in *Journal of Management Development* (Bradford, MCB University Press), 1990, No. 5, pp. 29-34.

CHAPTER VI

"IN-HOUSE" TRAINING

For large firms especially, enterprise-based or "in-house" training is the major - in many cases the only - means of preparing their staff to manage technological innovation. In-house training has many advantages, the foremost being that it can be tailored to meet a company's needs immediately.

Avionics - a case study

A recent research paper[1] on the impact of new work technology on the training of middle-level technicians describes the case of a European industrial company, identified by the author under the code-name Avionics.

Avionics is a leading European manufacturer of high-quality, highly specialised parts for the aviation industry. It employs mechanical, electro-mechanical, electro-chemical and electronic processes and, since its establishment in the 1960s, has maintained a zero-defect standard. In the 1980s international competition stiffened, domestic markets became weak, and it became obvious that technological innovations would change the workplace. The firm therefore had to be prepared for change, but what kind of change was by no means clear. An initial proposal by a technical college to introduce training in mathematics, science and applied science for company staff in order to facilitate technological change was discarded because only 3 per cent of the staff qualified for the course. The company opted then for an in-house scheme of "technological literacy" with the objective of preparing the entire workforce for change. The training programme - approximately 170 hours spread over three to six months and implemented by groups of 12 people representing a microcosm of the company - covered the basics of informatics, automation and modern manufacturing, besides economics. Knowledge was integrated with doing. Each subject was immediately practised by trainees using simulators or real machines, and actual operations were demonstrated by colleagues of course participants on the shop-floor. By the end of the course all participants had full knowledge of the entire operations of the firm - a global, concrete perspective an academic school could hardly provide. A number of evaluation exercises were performed, during and after the training programme. The objective was to ensure that all that was taught was actually used by the trainees, either during the course, or during the next few months.

The most visible result of the first groups was soon perceived by supervisors: graduates came out different from what they were before training. They were now pressing for changes; they wanted to participate; they asked more questions; they gave their opinions; they became more interested to learn; they asked for more autonomy. Two other consequences were immediately felt. First, supervisors and other higher-level technicians voluntarily applied for the course: they knew there were things to be learned. Second, over 50 per cent of those taking other higher-level technical courses were graduates from the basic technology literacy course.

Although training did not lead to dramatic changes in the workplace, it obviously facilitated the introduction of automation. However, it was not until the company received new contracts calling for major changes in the organisation of production (tighter deadlines, tighter cost control, more detailed documentation, new materials) that the value of this kind of training was fully appreciated. Adaptation came very swiftly. Personnel started moving from one post to the other, without many problems of adaptation. In the first year alone over 15 per cent of the total workforce changed jobs and performed adequately in the new functions. Training for flexibility seemed to have paid off, with positive dividends.

"Total quality" - the Corning Glass Works

Avionics' experience suggests that enhanced skills, new materials, and investment in better machinery and processes are of little use unless the workplace is reorganised, employees know the company better, and a common sense of purpose starts to appear. Training must therefore cover all aspects of a company's operations. Even this is insufficient in today's competitive circumstances and uncertain conditions. What more can be done to ensure against imponderable factors?

One answer, adopted by Avionics, was its carefuly reappraisal of "quality", quality at any price being replaced by a new concept: what quality for what mission, at what price? The company understood that a reputation for quality would give it a more secure position in the market-place, and hence a kind of self-insurance.

Corning Glass Works illustrates this point. Corning Glass Works is a giant whose worldwide workforce totals 27,000, with almost one-quarter of them outside the United States: 55 per cent of these employees are engaged directly in manufacturing, and a large proportion of the remaining 45 per cent are engineers; 70-80 per cent of management staff are graduates in technical subjects, and 16 per cent of the manufacturing workforce have qualified through apprenticeships.

Corning has a list of important innovations to its credit. Its major product lines comprise a huge range of speciality glass and ceramic products, consumer products (dinnerware, cookware, art glass, etc.), optical fibre and electronic components for the telecommunications industry, and glass and ceramic products for scientific work and for the health services.

Competition obliges the company to undertake constant R&D (between 5 and 6 per cent of its sales income), to maintain business acumen at a high pitch and to pursue quality relentlessly. The company had a tradition of using "quality" as a competitive advantage, but its competitors had also been adopting this stratagem. It was in response to this challenge the Corning's management, which defined profitability and quality as the twin requirements for the company's success, developed the concept of "total quality".

Perceiving that its market share depended increasingly on the quality not only of its products and services but also of its management, Corning set itself the objective of becoming a leader in delivering products and services on time, error-free, and totally in line with customers' requirements.

Faced with the problem of young professional employees leaving the company, Corning borrowed in 1981 a training scheme previously developed by Texas Instruments. The aim of this scheme was to reduce turnover in the first three years by 17 per cent, to reduce the time needed to learn a company job by 17 per cent, to improve the quality of new employees' work, to convey to the staff a uniform understanding of the company's objectives, strategies and expectations and to build up a positive attitude towards the company and the communities in which it operates. The training was based on self-learning, based in part on extensive printed and video material that was made available in all six languages used by the staff. The company saved 630 million dollars through reduced labour turnover, while the cost of the training scheme was estimated at 170 million dollars - a net saving of 460 million dollars.

Today, between 600 and 800 Corning employees can be trained in "quality awareness" each month. The consequences have been considerable. One is that the training department has assumed a strategic role. Another is that attention has shifted towards the further development of skills and processes throughout the company. Because change is now looked upon as the natural course of things, both the management and the employees are now better able to cope with it.

The Motorola University

The pursuit of quality is the common denominator of the two cases outlined above. Fundamental to quality is continuous technical advance and development of new materials, innovation in new products and processes and the acquisition of know-how and skills. Yet, the cases suggest that a purely technical approach to "new" technology is not enough; a broader view is needed to ensure the success of new products, in which quality is a core ingredient.

That the Corning and other experiences are nowhere near the end of the "training" line is illustrated by Motorola, which recently converted a 7 million dollar training budget into a 120 million dollar annual investment in education. William Wiggenhorn, Motorola's corporate vice-president for training and education, describes this startling development:[2]

> ... Ten years ago, we hired people to perform set tasks and didn't ask them to do a lot of thinking. If a machine went down, workers raised their hands, and a troubleshooter came to fix it. Ten years ago, we saw quality control as a screening process, catching defects before they got out the door. Ten years ago, most workers and some managers learned their jobs by observation, experience, and trial and error. When we did train people, we simply taught them new techniques on top of the basic math and communication skills we supposed they brought with them from school or college.
>
> Then all the rules of manufacturing and competition changed, and in our drive to change with them, we found we had to rewrite the rules of corporate training and education. We learned that line workers had to actually understand their work and their equipment, that senior management had to exemplify and reinforce new methods and skills if they were going to stick, that change had to be continuous and participative, and that education - not just instruction - was the only way to make all this occur.
>
> Finally, just as we began to capitalise on the change we thought we were achieving, we discovered to our utter astonishment that much of our workforce was illiterate. They couldn't read. They couldn't do simple arithmetic like percentages and fractions. ... These discoveries led us into areas of education we had never meant to enter and into budgetary realms we would have found unthinkable ten years earlier.

Today we expect workers to know their equipment and begin any troubleshooting process themselves. If they do need an expert, they must be able to describe the malfunction in detail. In other words, they have to be able to analyse problems and then communicate them.

Today we see quality as a process that prevents defects from occurring, a common corporate language that pervades the company and applies to security guards and secretaries as well as manufacturing staff.

Today Motorola has one of the most comprehensive and effective corporate training and education programmes in the world and, in a recent leap of ambition, our own corporate university.

At Motorola University the company itself assumes responsibility for curriculum design and never contracts out, although running of specific courses may be contracted to individuals, colleges and universities. Courses may also be packaged as software or on video cassette, or arranged for satellite transmission. Some 1,200 people are involved in training and education at Motorola worldwide, including 110 full-time and 300 part-time staff at Motorola University.

Where the training department of Motorola is focused on the needs of the organisation, "Motorola University" encompasses the needs of individuals, the "residents" of the large corporation. Through structured material, the media and self-learning, Motorola takes the education to the public, and not the other way round. Education is no longer considered a cost, but an indispensable investment which yields returns. People in the company acquire marketable skills and grow in self-esteem and self-confidence. Motorola University produces closer association with schools and established universities, leading to the mounting of joint courses. Motorola has thus been able to narrow the gap between itself and the academic world.

Siemens - a European giant

Large European companies - Siemens is a significant example - are today making education and training investments comparable to their United States counterparts. Innovation, the pursuit of quality, technology-led growth, etc. are now nurtured as carefully in Europe as in North America.

The example of Siemens demonstrates how the ostensibly practical nature of Germany's educational and vocational training system finds its natural extension in later education and training in the company.

Siemens is one of the world's largest corporations, employing 300,000 people in 1988-89. The composition of its staff has changed considerably over the years. Between 1962 and 1989, the proportion of semi-skilled workers held constant at 44 per cent, while the proportion of skilled workers rose from 23 to 34 per cent and of professional engineers from 10 to 20 per cent.

Siemens' "training" investment in the fiscal year 1988-89 was 300 million Deutschmarks for the company's blue-collar workers, technicians and commercial employees (80 per cent, 7 per cent and 13 per cent respectively). Investment was 460 million Deutschmarks for continuing education and training in technical subjects, data processing, manufacturing and management studies. The company is currently mounting 17,000 education courses of all types each year: this corresponds approximately to 4 million person/hours of attendance annually by more than 40 per cent of the workforce. It has 50 training sections, 20 product-orientated schools, three training centres and a major Management Development Centre. There are 800 full-time vocational training staff, while 700 full-time and 3,000 part-time instructors make up the teaching staff for the "continuing" education programmes.

In the United States firms have difficulty in assimilating inadequately prepared school-leavers. This is not the case in Germany. At Siemens in 1989 the school system supplied an "in-house" population of 9,350 manufacturing, 630 technical, and 1,400 commercial apprentices. The intake of manpower is large, and the training is very much of a "hands-on" nature.

Through its training programmes and training infrastructure, Siemens seeks to teach its personnel to adapt to changing work content and requirements and to promote flexibility in staff deployment. At the same time, it attaches increasing importance to "supra-technical" educational objectives, by emphasising the development of the desire to learn, problem-awareness, capacity for cooperation and creativeness. These non-technical skills are considered key requirements for keeping pace with technological change.

Notes

[1] J.B. Oliveira: Coping with the uncertainties of high-tech: The case of Avionics, available on application to the author, c/o ILO, Geneva.

[2] W. Wiggenhorn: "Motorola U: When training becomes an education, in Harvard Business Review, July-Aug. 1990, pp. 71-83.

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CHAPTER VII

INDUSTRY AND EDUCATION AND TRAINING INSTITUTIONS: NARROWING THE GAP

Massive, company-sustained "in-house" education departments are the prerogative of the larger organisations. They alone have the resources to make themselves largely independent of governments and their agencies. What, then, are the options of medium-sized to very small companies which cannot finance their own R&D and have very small budgets for training?

The remoteness from industry of traditional education and training schemes stems more than anything from a mutual lack of understanding, the two worlds tending to stay apart unless deliberate attempts are made to bring them closer together. Whenever academia has been a privileged reserve, with its own unquestioned claims to teaching, scholarship and the pursuit of knowledge, it has not been found to have much in common with innovative products, their manufacture and their marketing. On the other hand, industry has frequently shown itself incapable of formulating its problems, even when it has been able to make resources available for solutions to be sought elsewhere.

To bridge this gap industry has taken to appointing consultants from the academic world, sponsoring projects, supporting "sandwich" courses, financing research, providing specialists for seminars, and so on. Some notable successes have been reported, and the gap is now narrowing and closer integration being achieved. Major beneficiaries of this process have been smaller industries operating in fields of "new" technology, a sector which did not command much attention from governments prior to 1970.

What does the vast group of small and medium-sized firms need in order to prosper? One notable problem is that they are short of skills and talent. It has been noted, for example, that the European car industry's tendency to reduce the number of its apprentices when the market is contracting, deprives small and medium-sized firms of needed skilled workers, inasmuch as they tend to employ workers who had been trained beforehand in larger companies. The Ecole Technique de Sainte-Croix in Switzerland, the Teaching Company Scheme in the United Kingdom and the Steinbeis Foundation in Germany are three successful models of collaboration between training institutions and industry to meet the skill needs of small and medium-sized firms.

Ecole Technique de Sainte-Croix, Switzerland

The Ecole Technique de Sainte-Croix is a technical school which trains young people for jobs in Swiss industry. As part of an agreement with the authorities, the school sells products and services on the market in order to earn part of the income needed to run the school. For this purpose, the teachers at the school have created an enterprise, Swissperfo, which today receives grants from the Government and other contractors to develop new products, particularly in the area of computer-aided manufacturing and robot equipment. Swissperfo then contracts the services of the school to do the development work.

The school's curriculum is well structured and carefully targeted, and the school is extremely well-equipped. It offers a three-year technical "baccalaureat" course, a four-year precision mechanics course, and a four-year electronics technician course.

The theoretical base of all the courses is assured, but there is a strong "hands-on" bias and the most modern techniques and equipment are employed, including computer-aided manufacturing and design, numerically controlled machine tools, flexible manufacturing systems employing robots, etc. The school is closely integrated into the community, which includes firms employing "new" technology, and collaboration takes place at various levels of skill. Attention to detail, quality and "up-market" products is noteworthy.

The Teaching Company Scheme, United Kingdom

The development of skills required by production controllers, marketing experts, design engineers, R&D directors and managing directors is vital to the success of enterprises. The Teaching Company Scheme (TCS) in the United Kingdom is specially designed to address the development of these professional skills for industry. The TCS is funded jointly by the Science and Engineering Research Council, the Economic and Social Research Council, the Department of Trade and Industry and the Northern Ireland Department of Economic Development.

The TCS operates through teaching company programmes whereby a university or polytechnic appoint high-calibre graduates to work for two years as teaching company associates with firms wishing to make major changes in their methods of work. The scheme has four related objectives: to develop able graduates for careers in industry; to contribute to technological advance and enhance innovation in industry; to improve industrial performance by resorting more intensively to academic resources; and to develop the skills and talents of researchers through continuing and direct involvement with industry. The TCS has also increased industry's awareness of the talents and facilities available in universities and polytechnics for innovation and technological advance.

Currently, more than 1,500 graduates are engaged in TCS programmes. These provide an opportunity for "hands-on" industrial experience and to develop the personal qualities that are demanded from senior industrial personnel. Academic staff and company executives jointly design each programme. The young graduate enrolled as a teaching company associate is paid a normal industrial salary to work on a project under both an academic and an industrial supervisor.

The work and equipment for the project may be situated in industry, on a training institutions's premises, or both. The associate may also (outside the TCS scheme) register for a Master's degree or a Doctorate. An associateship has a duration of two years, and the entrant must as a general rule be under 28 years of age, possess a good university degree, and be interested in pursuing a career in British industry.

The majority of associates are engineers, but the physical sciences, information technology, management studies, mathematics, economics, the behavioural sciences and other fields are also represented. The sectors which have been recruiting associates for TCS programmes involve mechanical engineering, textiles, electrical engineering, pharmaceuticals, chemicals, biotechnology, new materials, plastics and rubber processing, microelectronics, information technology, civil engineering and construction, business strategy and marketing.

Large and medium-sized enterprises generally present no problem but with small companies, some of which are highly innovative, special arrangements may have to be made. One such arrangement is the "multi-company programme", whereby a consortium of companies becomes the industrial member and the associates are shared among them.

The TCS is not necessarily restricted to "new" technology projects, although most are. Any problem that may arise between the initial conception of a product and final delivery to the customer is material for a TCS programme. TCS is a valuable system for emergent technology, as it places emphasis on initial academic competence and "hands-on" learning. Undertaken only by already committed individuals, it is economical in expending its considerable resources for people who are likely to make a career in industry.

Currently 42 universities, 30 polytechnics and six other major educational institutions are engaged in 244, 104 and six TCS programmes, respectively; the number of associates may be higher since several may work with any given programme. Over 800 programmes have been undertaken in the 15 years that the scheme has been operating. The following examples of TCS programmes illustrate their considerable range.

Four associates were recruited for a programme commissioned by Ferranti Computer Systems Limited. The broad aim of the project was to make the company's information system more cohesive and accessible, with the emphasis on cost-effectiveness and quality, and involved a company-wide survey of the training needs of software managers, software development, the creation of a massive database and data analysis. According to the industrial project supervisor, the project had far-reaching implications for many of the company's research, development and manufacturing sites in the United Kingdom.

Another programme, for Transfer Technology Limited of Birmingham, was designed to apply research findings to new production processes in electrochemical machining, electrical discharge machining and ultrasonics. The company is relatively new, and manufactures innovative products for the aerospace, steel and car industries. Three associates were recruited to work on three highly specialised projects: production of very fine longitudinal holes in turbine blades, development of the company's electro-discharge texturing system, and creation of a new ultrasonic range-finder. Each associate was directly involved in one of the three areas of expertise vital to the company's development, and on completion of their TCS contracts two associates moved straight into middle-management roles.

The Polytechnic of Central London is currently collaborating with a manufacturer of specialised airborne computing equipment. Much of this equipment is custom-built, its design and manufacture is complex, and long lead times are customary. The purpose of the programme is to shorten the lead time and improve competitiveness. Three associates have been recruited for two years, working mainly on company location; 70 per cent of their salaries are paid out of government funds, and 30 per cent by the company. One associate is working on improving design and manufacture, another on customer-client relations, production schedules and related matters, and the third on information flow and engineering data management. A fourth associate will be recruited in the near future.

The final example is of four teaching company associates who were recruited to provide an objective view of a company undergoing continuous change. The company, which produces quality specialised parts for engine manufacturers, has in the last ten years been introducing new techniques, systems and technology that its employees have had to assimilate. The company accepts that its traditional methods of training have to change and is planning to introduce new production methods and improve productivity, quality and lead times. The teaching company programme is expected to achieve the dual objective of affording experience for the four associates and of having a spin-off effect in the form of more effective training for the regular workforce. The expected benefits include a higher return on capital as a result of improved plant utilisation, product improvements, reduced stocks and improved use of materials, reduction in labour demand owing to more intensive use of plant, greater job satisfaction and better work attitudes.

Steinbeis Foundation, Germany

The Steinbeis Foundation is an agency of the State of Baden-Württemberg (Germany) that promotes technological development in medium and small-scale industries. Its success may be judged from the fact that it is 90 per cent self-supporting.

The Steinbeis Foundation engages in the same form of "hands-on" training as the Teaching Company Scheme. University facilities and staff are available for training and knowledge transfer, supported by 12 core Steinbeis staff and more than 2,000 full-time and part-time project workers. Stipends are tailored to success and achievement. The advantage of this arrangement for the public finances is manifest. Around a thousand university professors are willing to do work for the Foundation, thereby contributing a wide-ranging technological input at no investment cost other than their own fees. Approximately 200 engineers, mostly university graduates, are also employed full-time on fixed-term contracts, and every year some 700 students engage in projects. The benefits are similar to those of the TCS, but the organisation is different: university staff are made available to small and medium-sized firms (and in turn receive industrial experience without any need for public investment); project workers and students receive "hands-on" training (this matches industry's needs and is conducted under contractual conditions); and R&D is conducted for the contracting company (secrecy and confidentiality are assured by the Foundation).

The Steinbeis Foundation is an effective response to the dynamics of development of "new" technology. It embraces a "total technology" concept and can summon advice on financial matters, marketing, production systems, facilitating inter-company cooperation, workforce training, and the formulation of industrial strategies. The success of the Foundation is based on the consistent implementation of pace-setting technologies in products and processes with market potential.

The education and training of unskilled and semi-skilled shop-floor workers is usually problematic, and mistakes can be costly. The Steinbeis Foundation's activities in facilitating training in medium-sized industries are therefore instructive. The problem was seen clearest when "assembly-intensive" industries, on introducing automation, found themselves forced to lay off unskilled and semi-skilled workers or to adopt expensive solutions. Under the Foundation's auspices, a company-specific programme was developed for training women assembly workers at RAFI GmbH - a task which was not suited to governmental intervention, was inappropriate for academic institutions and was beyond the contracting company's means. Two courses were developed for the company: training women as system operators in the robotic and flexible automation sectors; and training women for storage and quality control work at display terminals, with the possibility of promotion to supervisory positions. Higher pay for those completing the course was added as a further incentive.

It was the responsibility of the Foundation to draw up the curriculum and hold the courses, to provide scientific and technical advice and advise trainees at various phases of the training, to devise procedures for continuous, practical training, and to submit proposals for a training centre. At the end of the course, unskilled and semi-skilled women were found to have been much more ready to learn than had previously been expected. What they needed was motivation, appropriate teaching methods and a teaching schedule that fitted their work. The training objectives were met, and other benefits ensued: manufacturing costs were reduced even though higher wages were paid after the training; many former production-line workers could attend to minor outages on robotic and other production equipment, thereby reducing down time and improving equipment utilisation; technical supervision costs were cut; workers experienced greater job satisfaction; and product quality was improved.

CHAPTER VIII

SUMMARY AND SUGGESTED POINTS FOR DISCUSSION

Summary

Technological change, employment and work

The predominant conclusions of Part 1 of this report are that recent technological changes in industrialised countries have had varying labour effects in different sectors and countries. The long-term decline of employment levels in total manufacturing and major industries in many European and other OECD countries as a result of long-term structural changes is certainly continuing, but only partially because of technological innovations that eliminate jobs (particularly unskilled work) and reduce labour/output ratios. In several sectors technology is being adopted to improve flexibility, quality and competitiveness of output with existing employment levels or small employment growth. With few exceptions, however, the current workforce has been far less affected by recent technological changes than may have been expected from earlier predictions. Job losses directly attributable to the introduction of microelectronics-based technology have been smaller than those caused by economic recession and organisational changes, although in some cases these changes have been promoted by new technology.

None the less, there have been short-term negative effects on employment structure, on certain occupations and on lower-skilled workers which are not negligible in some countries and sectors. On the existing workforces these negative effects have been alleviated by moderate business growth in some sectors, redeployment and early retirement in many cases, changes in hours of work and retraining measures. To some extent firms have avoided dismissals due to technological change by making their existing workforces more flexible in terms not only of hours of work but also of job content, earnings and other aspects of work. Different forms of labour flexibility have advantages and disadvantages, but in some cases flexibility turns out in fact to mean a certain precariousness of employment - low job security, unstable incomes, and limited mobility in the labour market. This precariousness, in turn, has to do with whether the stand-by workers have part-time jobs or casual or temporary jobs, and the income benefits that these types of jobs entail according to local employment legislation.

However, these findings have a short-term outlook. They can be misleading because situations involving few lay-offs often result from business growth and short-term effects that are evident before all the organisational rearrangements made possible by new technologies are put in place. Such findings may also be misinterpreted to mean negligible employment effects, which is clearly not the case when one looks at the composition and quality of employment.

The long-term direct effects of technological change on employment are likely to be worse than they have been in recent years. Even in countries where technological change will have significantly positive indirect effects on employment, the combined effects of structural, technological and organisational changes are likely to cause employment to grow less than the number of people looking for jobs as a means of income. The declining growth rates in the working age population in some countries (e.g. in eight out of 24 OECD countries) will alleviate unemployment but are unlikely to offset the labour-saving effects of new technology and other related changes (see figure 3). This reality is likely to have widespread implications for employment and social security policies, for labour market adjustment, education and training, and for overall economic planning. What measures need to be formulated to deal with these issues?

In comparison with recent experience there would seem to be less cause for optimism about the means of coping with the possibly negative long-term employment effects of new technology and related organisational changes. Depending on economic growth rates and labour force participation rates, some societies may need to consider making adjustments in their patterns of economic growth and distribution of investments in ways which can create jobs that are consistent with the needs of their labour markets. As of 1992 a united Europe may to some extent help meet the challenges of employment creation by converting national unemployment and underemployment problems into more manageable problems of labour mobility.

The trend towards the use of new technology to improve flexibility, quality and competitiveness of production with the existing workforces has been largely acceptable to unions, which have to be mainly concerned about the existing labour force, but problematic for governments, which may be faced with rising unemployment in the future and a mismatch between the skills of young jobseekers and the skill requirements of increasingly advanced technology. The deskilling of some standardised tasks, particularly in industry, may possibly alleviate the mismatch of skills but probably much less so than earlier literature tended to predict. In some industries and in most service sectors, skilling effects associated with both vertical and horizontal job loading are more evident than deskilling effects.

The above discussion of technological change and employment has to be regarded as a rough summary from studies on some OECD countries. Having in mind ILO objectives and the tripartite constituency of the Meeting to which the report is addressed, it is important to place such a discussion in an overall economic context of development problems and policy issues and options in different countries.

The employment effects of technological and related structural changes tend to be perceived distinctively in different countries. This varying perception depends on whether their political and institutional machinery is committed to the pursuit of full employment as a fundamental objective of economic development, how well their economies and institutions can cope with frictional and long-term structural unemployment, how dependent they are on exports of manufactures where new technologies tend to play a key role in raising competitiveness and national income, etc.

Depending on its magnitude and speed, technological change can have pervasive and diverse economic effects in different countries. It affects employment and other aspects of work through changes in resource use, but it also affects income at the level of the economy, firms and individuals. As a result, a major question facing many developing countries and several European countries is whether country conditions make it possible for similar levels of national income to be achieved with significantly different levels of employment resulting from alternative packages of technology.

Another key issue is that efficiency in resource allocation from the perspective of individual firms may not always be optimal for the whole economy. For enterprises producing for highly competitive international markets, in general, new technologies can often (though not always) have a positive net impact on both the firms and the economy. In these cases employment growth tends to decrease, or increase less than output, but the indirect employment effects of additional income are in many cases likely to compensate for the direct employment effect of new technology. This has led some governments to subsidise investments in new technology for sectors such as textiles, electronics, etc. However, these policies can sometimes go too far and create price distortions that may cause inefficiency in resource allocation. In addition, managers may not always be in a position to make optimal decisions on technology even from the standpoint of their enterprises, possibly because of deficient information and advice, imperfections in supply of equipment and other problems.

A new technology which may be profitable to a specific enterprise or group of firms may not always be profitable to the whole economy. This can happen, for example, if such profitability is achieved by selling at a price much higher than cost where the government tries to promote growth by subsidising costs and by letting prices rise in protected and monopolistic markets. Thus, by looking at specific cases of investment in new technology from the viewpoint of the firm's accounting practices based on market prices, it is not always possible to conclude whether that investment is positive. negative or neutral from the economy's standpoint. From the perspective of the whole economy, some technologies may be more efficient for a certain proportion of labour, capital and skills, and may be more desirable under certain economic circumstances and labour market conditions than others; the nature of benefits from the use of some advanced technologies may also make them more profitable to firms and/or society in some sectors than in others. Their net economic impact depends on several factors, including: the relative availability and opportunity costs of capital and labour; the labour-saving effect of the technologies; the extent to which this effect is compensated by output diversification, increased competitiveness in the internal market and abroad and income from exports; the availability and regional distribution of skills; the relationship between the growth rate of the labour force and the growth rate of employment; the manner and the extent to which productivity gains are reflected in production costs, prices, profits, further investments and wages; the extent to which the supply of new technology generates domestic growth or drains foreign exchange, etc.

For the capital-rich European countries, technological change is believed to have a net positive economic impact and a manageable effect on employment. New technologies have been broadly regarded as a stimulus to competitiveness and growth in demand while promoting further growth in R&D, production and adaptation of new technology. In a few of these countries, notably Germany (Federal Republic) - at least until German unification - the overall economic effects of recent waves of technological change have been clearly positive. This outcome is somewhat less clear, for example, in the United Kingdom and France - and perhaps even in united Germany - which face more severe problems of unemployment and underemployment among young jobseekers and related maladjustments between the supply of and demand for skills.

For labour-supplying countries such as Portugal, Spain, Turkey and Yugoslavia, where foreign exchange is scarce and foreign borrowing is expensive in the long run, the role of new technologies cannot be assessed without a rigorous analysis of sector-specific needs, policies affecting immigration and labour markets in labour-absorbing countries, etc.

For Eastern European countries determined to modernise their economies (but faced with shortages of foreign exchange) while maintaining their commitment to the social objective of full employment, new technologies may have very mixed effects. The pervasiveness of these effects may call for *ex ante* assessments of alternative growth strategies, including the role and limitations of export-oriented growth, the debt-related implications of alternative modernisation paths and their debt management issues, the institutional implications of reforming existing training programmes and facilities, and the implications of existing regional imbalances in some countries for technological modernisation.

Some special considerations with respect to Eastern Europe

During the past 25 years or so, there has been no period of significant nation-wide unemployment in any of the Eastern European countries. It appears that the key problem has been that full employment has been accompanied by low levels of productivity. For example, in the mid-1980s labour productivity in Eastern Europe was roughly 60 per cent of the level in the European Economic Community.[1] In principle, this seems to make a good case for technological modernisation. But at what rate? In analysing this question one should first consider the fact that in some Eastern countries, and most notably the USSR and Germany (Democratic Republic), the relatively low productivity of labour has been partly a result of social policy and the lack of response of the economy to innovations rather than of the lack of technological capacity. This means that technological modernisation could be speeded up under favourable economic conditions, but it probably also means that social policy might have to change as regards the promotion and security of employment.

The labour market in most of those countries is expected to change significantly in the 1990s and early next century. There will be a contraction of demand for labour resulting from economic reforms, technological modernisation and increased efficiency. In contrast, a baby boom since 1989 in Hungary and other neighbouring countries will increase labour supply over the next fifteen years or so.[2] As efficiency criteria will increasingly influence decisions on technology and the hiring, retraining and promotion of employees, it may be more and more difficult to promote new areas of activity that can maintain full employment, which has hitherto been recognised as a duty of the State. The more the economic and financial system compels companies to use their workforce rationally, the smaller will be the scope for continuing to follow the employment policy orientations of recent years. Will every worker be guaranteed protection against the risk of unemployment throughout his or her working life as in the past? Will people be prepared to adapt themselves to the changing requirements of the labour market, to acquire new skills, to relocate to other regions? It is perhaps the nature more than the size of the adjustments to technological modernisation which may pose the greatest challenges.

The special case of the USSR deserves some additional remarks in so far as it has great capacity for technological innovation but tremendous labour market problems, which call for a cautious approach to technological change.

In 1989 the working age population was 164 million, of which only two million were not employed and actively looking for work, i.e. "people applying to the employment service for help in finding a job". According to some estimates, however, the surplus of labour will have grown to about 8-10 million people in 1990,[3] and is likely to be much higher in 1991.

The release of workers as a result of economic restructuring is new in the USSR. Until recently, "release was understood (even in legislation) as a shift to another job at the same enterprise, with a change of place of work and, if necessary, occupation as well, without cancellation of the labour contract. From 1987, with the adoption of the Law of the State Enterprise (Amalgamation), the transition to enterprise self-financing and a widespread introduction of progressive forms of labour organisation, the release process has been accompanied by cancellation of labour contracts. ... In total, about 1.5 million people were released from state enterprises in 1989" and similar levels were "expected to continue over the period 1991-95." According to preliminary estimates, "the number of industrial, office and professional workers in the state-owned sector will fall by 20 million people by the year 2000", well above a projected increase of 12 million people in expanding sectors. Forecasts made in 1990 projected a shortfall of 1.4 million jobs in 1991.

These labour surpluses and the consequential unemployment - if correctly estimated - remain relatively small by Western standards and do not seem unmanageable given the size of the Soviet economy. It is the nature more than the extent of the adjustments which may pose the greatest problems. Some sectors expand while others shrink, requiring a sectoral and regional redistribution of manpower in a labour market which has had low geographical mobility and inadequate training in labour-surplus regions, particularly in the republics of Central Asia, Azerbaijan and the southern regions of Kazakhstan.

Skills have been generally underutilised, but there may be critical limitations in available skills to cope with a fast pace of technological change even if training and retraining facilities can be effectively upgraded. About 70 per cent of the workforce are manual workers and approximately half of them work in non-mechanised workplaces.

In summary, the pervasive intersectoral nature of recent innovations in electronics, information processing and telecommunications make technological change inevitable for most sectors and countries. This trend cannot be reversed or stopped although several pertinent questions should be raised about the magnitude and speed of technological change and the means of adjusting to its effects. These questions are most relevant, though not exclusively, for Eastern European countries which are faced with the adjustment problems of ongoing economic reforms together with severe regional imbalances between the supply of and demand for both labour and skills. These problems should play a decisive role in government decisions to influence the rate of technological change as well as its sectoral and regional scope. There is no doubt that technological modernisation is imperative for raising efficiency and for the attainment of economic reforms in Eastern Europe. But at what rate? What other changes will be required to optimise the benefits of technological change?

Training for new technology

Part 2 of this report does not attempt to provide firm conclusions and definitive proposals. Rather it seeks to show that training for new technology is best carried out in an industrial context. There is no corpus of new technological skills, as such. The prime task of the education system is to disseminate technological and scientific know-how in general. (It must not, however, be assumed that this process leads directly to new technology, which is only a current phase of what is often termed "total technology".) As far as key personnel are concerned, it is only "hands-on" education which effectively yields the experience and skills required, as distinct from the invaluable background knowledge.

No claim can be made that the examples given in the text are the best, but they are known to be effective. They do in any case suggest that industry offers the best location and often the best conditions for training, and this despite the fact that new technology is not absent from academic institutions and that some have made considerable progress in technological development. The gap between industry and academia is narrowing, but further effort is necessary for them to function to their mutual advantage. It is essentially the responsibility of industry itself to collaborate with the academic institutions on training schemes for total technology, and the past decade has in fact seen the very large corporations and even some smaller firms going beyond training as such and establishing broader education schemes, including company-sponsored universities.

Progressive managers have recognised that workforce training is not only a necessary investment for their company but yields a cost-effective return. Large international corporations not only have the motivation but can make resources available for education and training. Medium-sized companies, and certainly small ones, are less well-placed and must often either do without or depend on various types of government-sponsored schemes.

It is clear that the gap between the academic and industrial worlds cannot be closed by decree. If the two are to move closer together, then they must have access to each other's accumulated knowledge and experience. The most effective solutions would appear to be those implemented by independent but publicly accountable bodies, such as the Teaching Company Scheme in the United Kingdom or the Steinbeis Foundation in Germany.

To conclude, this report contends that training is a function of the dynamics of "new" technology and the industry which it sustains, and of which it is an integral part. Only to a minor degree is it a function of public policies and systems of education. The latter are certainly necessary to societies, but they are of a preparatory and supportive nature vis-à-vis the mainstream of training and training developments in the industrial sector, with or without governmental support.

Suggested points for discussion

The following questions are offered as a basis for discussion to enable the Meeting to adopt appropriate conclusions on the questions considered to be the most important. The Meeting may of course modify or add to this list or adopt another procedure.

1. Promoting optimal choices of technology

(a) In what conditions and to what extent should government policies, tripartite agreements and other forms of collective bargaining seek to mould the rate of technological change with a view to optimising its economic impact, or should the market forces prevail?

2. Adjustment to technological change in Eastern European countries

(a) In what conditions and to what extent should increased efficiency and productivity be given greater priority than the maintenance of full employment? What measures may be required to accommodate both objectives?

(b) What new role can be expected of government and labour unions as enterprises seek greater independence and higher efficiency and while existing government institutions are shaped to cope with increased demand labour turnover and job-procurement services and with the increased demand for new skills?

3. Flexibility vs. security and employment

In what conditions and to what extent should:

(a) part-time workers be eligible for unemployment compensation?

(b) part-time, casual and other irregular workers be given equal opportunities for training and retraining?

4. Improving the capacity of training to cope with technological change

(a) By what incentives can public authorities encourage firms to increase the training of their staff?

(b) By what means can public authorities promote training schemes that combine "in-house" training in firms and school-based training?

(c) What role can trade unions play in overcoming the tendency of some firms to provide excessively narrow and shortsighted training?

(d) Has the traditional distinction between education and training lost its relevance for modern industry?

5. Role of the ILO

What role, if any, should the ILO play in assisting the social partners in their efforts to cope with the employment and training implications of technological changes and related structural and organisational changes?

Notes

[1] A. Samorodov: "Coping with the employment effects of restructuring in Eastern Europe", in International Labour Review, 1989, No. 3, pp. 357-371.

[2] C. Halmos: "Political and economic reform and labour policy in Hungary", in International Labour Review, 1990, No. 1, pp. 41-57.

[3] The information and quotations cited in these paragraphs on the USSR are taken from V.F. Kosolov: "The new employment policy in the USSR", in G. Standing (ed.): In search of flexibility: The new Soviet labour market, pp. 45-61; and V.G. Kostakov: "Labour surplus and labour shortage in the USSR", ibid., pp. 81-105.

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