CHAPTER III

THE IMPACT OF TECHNOLOGICAL CHANGE ON EMPLOYMENT

AND

AGREEMENTS FOR NEGOTIATING TECHNOLOGICAL CHANGE

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February 1985

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THE IMPACT OF TECHNOLOGICAL CHANGE ON EMPLOYMENT

I. IMPACT ON THE LEVEL OF EMPLOYMENT

Introduction

Economists have traditionally been optimistic about the long-term relationship between technological change and employment levels in general. Technological change brings about job displacement but it also brings about job creation and the conventional wisdom is that at least in the long term the latter process outweighs the former.

A quick review of the experience of industrialised countries since the industrial revolution of the 19th century would support this optimism. Despite the widespread introduction of labour-saving machinery in industrial production in Britain in the early 19th century for example, employment in manufacturing grew from less than 2 1/2 million in 1841 to more than 6 million at the end of the century[1]. This growth took place partly because the growth in demand for manufactured goods, both domestically and worldwide, exceeded the growth in labour productivity brought about by technological change. The benefits of technological change have not all been taken in the form of increased growth and income however. In industrialised countries working time has also fallen consistently over the last hundred years. In Britain between 1890 and 1951 the reduction in labour input as a result of reduced annual working time was equivalent to 25 per cent of the increase in

(1) B.R. Mitchell: European Historical Statistics 1750-1970, London 1978.

hourly labour productivity[1].

Similarly, widespread fears were expressed in the United States in the 1960s of technological unemployment arising out of automation of industrial processes. Yet, despite increased automation, employment grew from 65 million in 1960 to 105 million in 1984.

It is also clear that in the long-term the successful exploitation of the opportunities offered by technological change is a necessary condition for developing countries to raise their general standard of living.

There has been much less complacency however about what the immediate effects of technological change on employment are likely to be. In industrialised countries such short-term worries tend to come to the fore during economic recessions and recede somewhat during periods of faster growth. Thus, in the OECD countries between 1974 and 1984 unemployment increased from 3.9 per cent to 8.5 per cent of the labour force. At the same time concern had begun to mount, particularly in Europe, at the job-reducing potential of the introduction of information technology based upon microelectronics. In the Federal Republic of Germany, for example, the press in 1975 dubbed the microprocessor as the 'job killer'.

Much of the debate that has taken place in the last ten years over the employment effects of technological change particularly in industrialised countries has become polarised around the two separate views of the problem. The optimistic commentators have tended to look only at the long-term movement of economies from one equilibrium to another. The pessimistic commentators on the other hand have tended to look only at short-term displacement effects on the labour market without taking account of the possibility of compensatory effects.

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(1) Sir Bruce Williams: "Long Term Trends of Working Time and the Goal of Full Employment": Paper presented to OECD Conference on Employment Growth in the context of structural change, February 1984.

A more useful approach than either of these two extremes is to consider the processes which facilitate employment adjustment, whilst recognising that the movement from one equilibrium to another may be far from easy in terms of the incidence of economic and social costs and benefits on different groups of people. As Keynes pointed out, not only are we all dead in the long run but economists set themselves too easy a task if all they are able to tell us in the midst of the storm is that once the storm is past the ocean will be calm again[1].

Economists have also shown less confidence in making optimistic predictions about the impact of technological change on the distribution of employment. It is generally accepted that the possibility can certainly exist of serious imbalances occurring either over time or between geographical regions in the relative weights of job displacement and job creation. This means that the possibility exists of certain groups of people being permanently worse off in terms of employment possibilities as a result of technological change. This was recognised by the classical economists writing at the time of the industrial revolution in Europe. Ricardo wrote in his Principles of Political Economy and Taxation in 1817:

"That the opinion entertained by the labouring class, that the employment of machinery is frequently detrimental to their interests, is not founded on prejudice and error, but is conformable to the correct principles of political economy".

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(1) J.M. Keynes: Treatise on Money, 1930.

This section therefore addresses these two potential areas of concern, namely:- firstly, to what extent adjustment mechanisms may currently be inadequate in coping with the employment displacement arising from technological change; and, secondly, whether certain areas in the world and certain groups in society permanently lose out as a result of change.

The short term impact of technological changes

Technological change when it is applied to economic activity results in innovations both in products and in processes. New processes will normally save the primary factors of production, labour, capital and raw materials, for a given level of output in different industries. A particular innovation may also lead to the substitution of one factor for another in the production process. Product innovations are sometimes complementary and sometimes substitutes for existing products. The production of new products will also combine labour, capital and raw materials together in different quantities compared to the production of existing products. The general result of past technological change has been that the productivity of the primary factors of production has, on average, been raised.

The extent to which this development results in an increase in output or a reduction in demand for particular factors of production will partly be a result of the microeconomic mechanisms by which the potential cost savings are distributed through price or income changes. It will also be a result of the macroeconomic environment and the overall level of demand. The shape of technological change may itself affect these developments

and be affected by them. For example it is generally agreed that labour-saving process innovation is more likely to have an overall negative impact on the demand for labour than product innovation. The job-creating impact of particular product innovation is, however, likely to vary over a product's 'life cycle', with a growth phase being followed by maturity and eventual decline. The extent to which job-creating product innovations come 'on-stream' is however also likely to be affected by microeconomic market structures and the macroeconomic environment.

The general conclusion is that technological innovation leads to both the creation and destruction of jobs. The balance between the two effects will determine the effect on the level of employment. In the short term at least this is not likely to be inevitable or fixed but is rather likely to be a result of the microeconomic adjustment process and the macroeconomic environment.

Market adjustment processes

Outside the centrally planned economies microeconomic adjustment takes place through a mixture of market forces and public intervention.

As seen, the most common effect of technological innovation is the increase in the overall productivity of factor inputs. The welfare gains brought about by this will be distributed differently in different national and different market situations. In a hypothetical perfectly competitive situation an enterprise would pass on all the welfare gain to the consumer in the form of a reduced price for the product being produced with the various factors. This reduction in price would then lead to an expansion of demand for the product. If the expansion in demand is proportionally greater than the increase in productivity and price reduction then, other things being equal,

employment in the firm would be expected to increase. If the expansion of demand is less than the increase in productivity, then the firms' employment would be expected to fall.

The initial price reduction would also have the effect of increasing the consumer's disposable income and this could stimulate increased demand for other products and so increase employment in other sectors not connected in any way to the product undergoing technological change. In industrialised countries technological change has to some extent allowed shifts in the labour force initially from the primary into the secondary and subsequently into the tertiary sector. This has reflected the fact that, in a given sector, the displacement of labour due to technological change has not necessarily been compensated for in terms of increased demand for the output of that sector but instead price falls have allowed the increase in demand and consequently output and employment in other sectors. Since the beginning of the nineteenth century, employment in industrialised countries has shifted from the primary sector to the secondary sector and subsequently to the tertiary sector.

It is interesting to note that most centrally planned economies, in theory at least, aim to distribute the gains of technological innovation in the same way as this perfect market. As incomes are in theory fixed, productivity gains are passed on as welfare increases in the form of lower prices.

In market economies the theoretical case of perfect competition can be contrasted with the opposite extreme of adjustment to technological change in a monopoly situation. In this case the monopolist will only increase output and lower prices to the extent that variable costs may be reduced by technological innovation. If fixed costs including fixed elements in labour

costs are reduced, then output will remain constant, employment may fall and all the welfare gain will be taken in the form of an increase in profit.

In the real world cases of pure monopoly are rare and cases of perfect competition even rarer. The result is that most adjustment to technological change takes place under intermediary conditions of imperfect competition or oligopoly.

The electronics industry, for example, which is at the forefront of technological innovation, is dominated by a few large general companies operating across a range of subsectors and a range of countries. There is a network of agreements, joint ventures and joint ownership links which has developed between these various groups of companies. The world computer market is still dominated by a single company, IBM, with 65 per cent of the world large computer market.

There do exist however market riches created by the proliferation of product lines which new companies can fill. Moreover in some areas barriers to entry into a market may be low. Technological innovation has spurred intense price competition in certain electronics subsectors such as production of mass-produced integrated circuits or home computers. Elsewhere however profit margins are increased and competition is muted. Corporate strategy is dominated therefore by reactions of a few competing firms to known innovations and potentially lucrative markets.

The market conditions in the industries which are involved in product innovation are perhaps less important than in those industries using new technology in new processes. Again, in many areas, the standard market structure is one of differentiated oligopoly. Under these market conditions the welfare benefits of technological innovation are neither distributed entirely in the form of price reductions nor retained entirely in the form of excess profits. The net employment effects of technological

change will depend upon the relative price and income elasticities of goods and services. Moreover, changes in income and employment of different groups in society as a result of technological changes may lead to secondary multiplier effects on income, output and employment.

Certain economists have explained the economic problems of simultaneously high inflation and unemployment experienced by industrialised economies as a result of increasingly institutionalised price and wage fixing in labour and product markets[1]. Under these circumstances it has been argued that in response to increases in demand firms will raise prices rather than output, and so have become insensitive to government demand management policy. It would be expected that this behaviour would reduce the expansionary output and employment effects of technological change and increase the displacement effects.

These observations suggest that although over sufficiently long periods price and income elasticities in industrialised countries have been sufficiently high to ensure that technological innovation has increased employment, this cannot be assumed as an a priori inevitability in the short term. The nature of market structures in both the industrialised and developing worlds suggests that it is unsatisfactory to assume that these are automatic mechanisms whereby technological innovation will itself create sufficient extra demand to re-employ the workers displaced by it.

Adjustment and the macroeconomic environment

The process of microeconomic adjustment to technological innovation will both affect and itself be affected by the macro-

(1) See for example : A.M. Okun : "Prices and Quantities. A macroeconomic analysis", 1981.

economic environment. In a period of recession with uncertain expectations as to future demand growth, firms will tend to operate more like monopolists in the face of technological innovation. Innovations will be used to reduce labour costs and employment and increase profit rather than to lower prices and expand output and employment. Investment incorporating new technology will tend to be biased towards rationalisation and job-reducing process innovation rather than job-creating product innovation.

One commentator has aptly summarised the situation:- "In periods of continuous economic expansion new products may be introduced and old products displaced, accompanied by a high level of search for a variety of labour skills and a high labour demand. In zero growth situations new products may have more limited success, the search therefore intensifies for cost-reducing techniques which are not altogether compensated by investment employment and so technology is seen to be displacing labour. The deeper the recession the more serious and the more rapid the impact of technology is perceived to be upon employment and job prospects"(1).

Overall therefore it would be expected that in a prolonged recession technological change would become biased towards rationalisation and labour-saving techniques. This could help to create structural unemployment. For industrialised countries the persistence of high unemployment and high levels of unused capacity over a substantial period of time is likely to lead to a country falling into 'the low growth trap'.

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(1) J. Goddard and A. Thwaites: "Technological Change and the Inner City", Social Science Research Council, London, 1980.

This is a reflection of the difficulties of making resources unemployed (both capital and people) and then expecting to be able to bring them back into production when needed, with no problems. The longer people and capital have been unemployed, the harder it is to bring them back into productive activity. On the labour side, a formerly skilled worker who has been unemployed for some years is unlikely to be able to move easily back into a skilled job, even if his former skills are still needed. On the capital side, after a certain period, companies are likely to disinvest and close down capacity that is unused. In macroeconomic terms in a recession, potential output will tend to adjust downwards to actual output after a time lag. So that after a period an economy may well be operating at full capacity but at a very low level production and with a high level of unemployment. In this way, cyclical unemployment is transformed into structural unemployment. There is evidence to suggest that this has taken place in a number of industrialised countries but particularly in the European economies since the late 1970s. The OECD noted that:- "... there is prima facie evidence that the rate of unemployment has risen relative to unused capacity during the 1970s. For six major OECD countries for which the OECD has made recent calculations of potential output, the apparent potential capacity shortage or the 'excess labour supply' in 1980 seems to be considerable...there has been an outward shift of curves relating rates of unemployment to rates of capacity use. If past relationships remain approximately valid, a return to full capacity use would not lead to a complete absorption of labour market slack."(1)

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(1) OECD : Economic Outlook, July 1982, page 26.

The policy outcome of this is that an increase in investment is needed to return to full employment. Moreover, investment is required which expands capacity, is capital 'widening' and is based upon product innovation rather than investment which simply rationalises production at existing levels of output. Such an increase in investment is however unlikely to be forthcoming as long as unemployment remains high and future demand prospects remain weak. This is the nature of the trap in which a number of economies find themselves.

Examples of job displacement with specific technologies

Against this background there has been considerable concern in industrialised countries in recent years at the potential job displacement arising from new technology. Much of this has focused upon microelectronics and information technology whose impact on employment has appeared to be the most extensive of all contemporary technologies.Most industrialised countries have carried out national surveys and literature reviews(1). The conclusions of these in general have been in keeping with the historical tradition of economists described at the beginning of this paper. Most official reports have been optimistic about the long-term impact of technology on employment, but considerably more concern has been expressed about the prospects for particular industries, occupations and groups in the short term.

There are obviously considerable empirical difficulties in identifying the impact of new technology on employment. Technological change is closely linked to other economic aspects

(1) For a Review of these national reviews see OECD, consultants' report for ICCP 2nd special session, October 1981: Stoneman, Blattner, Pastré,"Information Technologies, Productivity and Employment".

such as changes in the pattern of world trade, a changing pattern of consumer demand, changing relative factor prices and macroeconomic policy. Examining case studies of particular innovating firms or industries may overemphasize the job displacement or job compensation effect of changes. But also looking at innovating firms may miss the real impact of technology on employment because the job losses are likely to occur in non-innovating firms or countries which suffer a loss of competitiveness.

Despite these qualifications, it is worth noting that there is considerable prima facie evidence of quite extensive job displacement in industrialised countries over the last decade which is associated with technological change.

Microelectronics

In industrialised countries, and particularly in Western Europe, the impact of microelectronics can be seen to have displaced labour in three main areas over the last ten years.

The first area of job displacement has been in those industries manufacturing products in which mechanical or electromechanical elements have been replaced by microelectronic elements. In some cases this has resulted in a dramatic transformation of particular products. The industries affected include large parts of electrical equipment manufacturing such as telecommunications equipment, cash registers, calculating equipment, business equipment; it also includes precision tools and watches.

In these sectors the application of microelectronics has resulted in a reduction in the number of components of the

final product and consequently the amount of assembly work involved in manufacturing them. Standard Electric Lorenz produce an electronic telex machine in which one microprocessor has replaced 936 separate parts in its electromechanical predecessor. Electronic watches, are assembled from five basic components - a battery, quartz crystal, light emitting diode, integrated circuit and case. This is compared to the thousand manual operations involved in manufacturing a mechanical watch. Even allowing for a large expansion of production in some of these sectors, this has not been sufficient to provide employment growth and in some cases to avoid the loss of jobs. An OECD survey of the electronics industry has reported that: "employment in the majority of the United States electronics firms has not increased during the 1970s, whilst real output has risen considerably and sales revenue even faster...Employment trends in European firms followed the United States pattern".(1) One such company affected - the Italian firm Olivetti - carried out a survey of a number of companies producing mechanical and electronic business equipment products. The eight companies surveyed reduced their employment by 20 per cent during the 1970s, whilst undertaking transformation of their production systems away from mechanical and towards electronic production. The Swedish telecommunications equipment manufacturer, Erickson, reduced its production employment from 15,000 to 10,000 between 1975 and 1978 as a result of a changeover from producing electromechanical to electronic and semi-electronic telephone switching systems. In the countries of the European Community employment in electrical engineering fell by 338 000, or 14.2 per cent, between 1974

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(1) Science and Technology in the New Socio-Economic Context, OECD 1980. Sector study on electronics by Mick Mclean, University of Sussex.

and 1982. Employment in the manufacture of data-processing machinery and office equipment fell by 28 000, or 10.6 per cent, during the same period.

Technological changes in the electronics industry have also been combined with significant changes in the international location of production activities. All parts of the industry, with the exception until recently of telecommunications equipment manufacturing, have become highly internationalised with a tendency in many sectors for companies to locate labour intensive parts of production in low cost parts of the world such as the Far East, whilst retaining research and other activities close to their home base. A survey of the major US companies involved in integrated circuit manufacture(1) estimated that between 1974 and 1978 these companies increased their US semiconductor employment from 85,000 to 90,000, whereas overseas employment grew from 70,000 to 90,000 over the same period.

Probably the largest impact of microelectronics on employment in developing countries in the last ten years has been the growth in offshore assembly plants of US and Japanese electronics companies in newly industrialising countries. The expansion in employment in these plants has reflected a redistribution of world employment when the substitutive effects of microelectronics in industrialised countries are taken account of.

The second area of technology-related job losses has been where microelectronics has allowed a marked change in the production process. This has been primarily felt in industrial countries. Perhaps the best example has been in printing where microelectronics has allowed a changeover from hot metal to computerised typesetting, and this has had significant employment effects. In the E.C. countries employment in the printing, publishing and paper industry fell by 255 000, or 12.7 per cent, between 1974 and 1982. Jobs involving typesetting and graphical skills have been replaced by jobs involving data entry and data analysis.

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(1) U.S. International Trade Commission: quoted in United Nations Centre on Transnational Corporations (CTC) study on "The International Semiconductor Industry",1983.

Microelectronics is particularly suitable in automating industrial processes where existing jobs involve tasks which are repetitive or sequentially repetitive. An example of such an application is the development of robotics, in which straight substitution of human by mechanical activity takes place. Whilst the main use of robots up to now has been in the mass production industries, such as motor vehicles (where the majority of American, European and Japanese producers have introduced robots), metalworking, chemicals, civil engineering, electrical and electronic industries, their use will expand over the next ten years into wider fields of application.

The main tasks carried out by robots are those of assembly, joining and handling. A major American manufacturer of robots has estimated that 50 per cent of the machines it has installed have been used for spot welding, about 11 per cent for dye-casting and another 5 per cent for machine loading. With advances in the application of microelectronics, particularly in science or technology, universal machines are being developed which are able to carry out more complex assembly tasks.

A study on the introduction of robots in the Federal Republic of Germany[1] examined the introduction of ten robots in five companies in a variety of sectors. The tasks affected were arc welding, paint spraying and handling of pieces. The effects on manning requirement were that a total of 46 people in non-qualified jobs were affected; of these 7 were made redundant, 28 moved out of the sector, 10 changed jobs within the sector, and one moved into the sector. The introduction of robots therefore meant substantial labour displacement. In the British motor industry British Leyland has used robots

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(1) Battelle Institute, Frankfurt.

in its Mini Metro production line at Longbridge. Twenty-eight robots are used, with a high degree of central computer control. Only 38 workers are employed on car body assembly compared with 138 who it is estimated would be required on a conventional production line.

The third example of the job displacement effect of the application of microelectronics has been in the service sector. Microelectronics is resulting in the 1980s in the application of electronic data-processing more widely across the service sector in industrialised countries, allowing the automation of many office and distribution jobs. This is already resulting in a slowdown in employment growth in services such as banking and insurance, which have become important users of computers in the last ten years. In the 1960s employment in banking and insurance grew rapidly in most industrialised countries. In Europe growth was most spectacular in Belgium, where it averaged 10 per cent between 1964 and 1974. In France and Denmark annual employment growth was more than 6 per cent and in Germany and the UK more than 3 per cent. Between 1974 and 1982 growth had slowed substantially,to 1.3 per cent in Belgium, 1.6 per cent in Denmark, 2.0 per cent in Germany, 2.1 per cent in the UK and 2.7 per cent in France. This had been at the same time as a continuing growth in the demand for bank services.

Biotechnology

There has been less of an obvious impact on employment arising from the diffusion of other key technologies in industrialised countries over the last few years such as biotechnology, new forms of energy and new materials. Biotechnology may have

an important impact in the future on industries such as agriculture, food manufacturing, petrochemicals, pharmaceuticals and water supply in both developed and developing countries. However, its impact to date has been limited and it has not been developed to a stage where it has led to widespread production process innovation. An OECD report on the pharmaceutical industry in 1980 found that "until recently, the increase in staff resulting from higher production, greater activity abroad and the need for additional manpower to carry out new tests and other operations (metabolism, metagenesis, volume of data to be collected) has compensated the reduction due to gains in productivity and, in some cases, due to mergers or acquisitions. This comparative stability is today threatened by the deterioration in the economic situation and a deliberate policy of cutting down on staff members."(1) Firms did report increases in productivity due to technical progress in fermentation processes, in the production of chemical substances and in packaging, but recorded lower increases in general productivity than in the past. Any technologically induced changes in employment displacement have therefore been swamped by the effects of the recession.

The potential uses of biotechnology in the field of developing health applications such as new drugs and pharmaceutical products would seem to point the way to substantial production developments. Although such developments are unlikely to be highly labour-intensive once at the application and production stage, they should provide some source of employment growth in the medium-term, having primarily expansive rather than substitutive effects on employment.

In agriculture and the agrofood industry biotechnology may certainly lead to important product and process innovations. These may have important structural effects on the livelihood of those in the agricultural sector, particularly in developing countries. The EEC's Fast Team has warned that "while biotechnology offers new and valuable strategic options, it also inevitably threatens by substitution many established crops and activities, particularly if they currently command a high price".(2)

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(1) Science and Technology in the New Socio-Economic Context, OECD 1980. Sector study on pharmaceuticals.

(2) EEC: "The Fast Programme, Vol.1, Results and Recommendations, 1982.

An example is the case of isoglucose which is an effective substitute for sugar produced from starch using an inexpensive process originally developed by European firms. Outside Europe isoglucose production has expanded rapidly using starch derived from maize in North America and manioc in Japan. In Europe, however, its production has been limited through levy and quota restrictions with the aim of protecting European beet sugar producers. The protectionist option has not been open to cane sugar producers in developing countries, whose export earnings have been affected both by isoglucose production and by protection of sugar beet in Europe. The EEC's FAST team have said, somewhat idealistically, that coping with the structural impact of biotechnology "... demands sensitive management which assesses the value of competing technologies and permits a proper balance of interest to be struck, for example between the interests of 'isoglucose' manufacturers, sugar beet farmers, the citizens of Europe, and the Third World producers of cane sugar; or between the manufacturers of single cell protein and the importers or growers of conventional animal feed (or human food)."

The exact impact of biotechnology upon food production is a matter of conjecture. However, given earlier analysis of this paper, it is a matter of concern that the markets for processed food in most countries are dominated by a few large multinational corporations. This would tend to restrict the advantages to the consumer of technological changes. Some of the impacts with regard to developing countries are returned to later.

Energy

Energy technology will also have a key impact on employment in general in the future, although the issues at stake cover

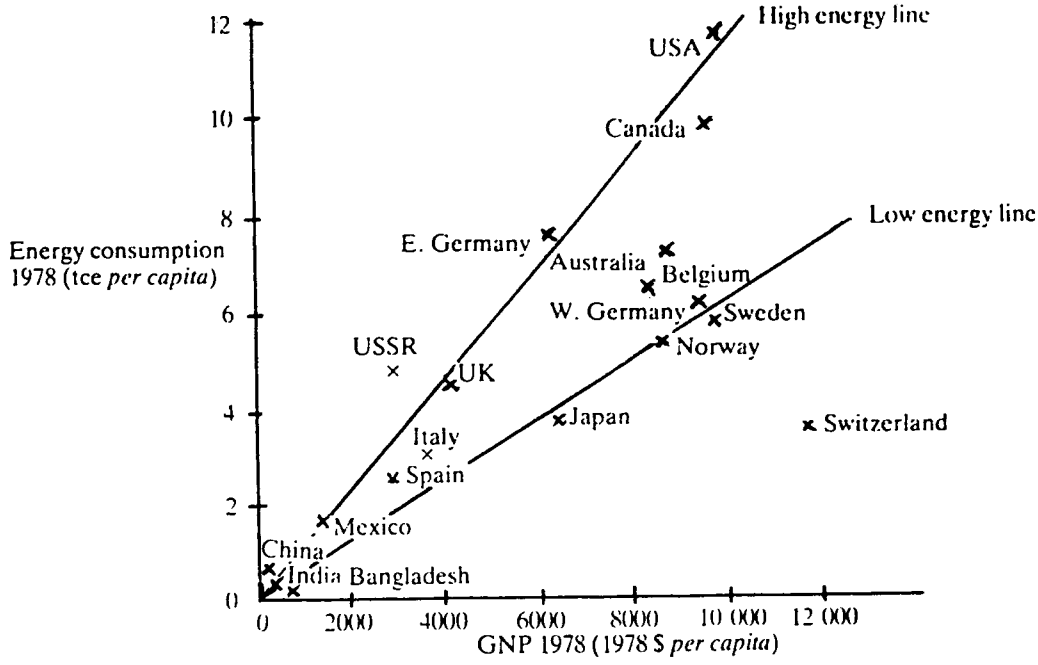
far wider questions than substitution effects between existing and future energy sources and questions of labour displacement. In the past, the substitution of one energy source for another has clearly had major displacement effects.

In the 1880s coal overtook wood as the main energy source in the United States, something which it had already done in the industrialising European countries. Employment in the coal mining industry grew rapidly in those countries to an historical peak in the mid-1920s. In the 1880s/coal mining employed more than half a million people in Britain and Germany, 200,000 in France and 100,000 in Belgium. By the mid 1920s the figure had risen to 1.4 million in Britain, 1.2 million in Germany, 450,000 in France and 200,000 in Belgium. In 1982 the employment in coal mining had fallen to 270,000 in Britain, 190,000 in Germany (Federal Republic), 59,000 in France and 23,000 in Belgium. During the period following the Second World War oil surpassed coal as the main source of energy worldwide and currently accounts for some 45 per cent of the world's commercial energy supplies.

Fossil fuels are still overwhelmingly the most important source for world electricity supplies. However, the oil price rises and supply problems of the 1970s have raised fundamental questions about long-term availability of existing fossil fuels. Most industrialised countries have embarked upon major programmes for nuclear energy, although these still represent only a few per cent of world energy supplies. Moreover, nuclear programmes have been beset with problems of very high capital costs, considerable technical difficulties and major safety and environmental problems. Alternative energy sources, such as wind, wave, solar and biomass, are quantitatively insignificant in terms of world production.

The future choices of energy technology will clearly have a direct impact upon employment patterns in those industries. More importantly however is the fact that they will reflect the energy intensiveness of future patterns of growth. Vast differences exist between the industrialised countries and developing countries in commercial energy consumption per capita. Thus, in 1947 the United States, with only 6 per cent of the world's population, consumed 47 per cent of the world's commercial energy supplies. That of the developing countries has however been increasing, partly due to increasing per capita use and partly due to increasing population. By 1974 the United States' share of world energy consumption had dropped to 30 per cent.

Energy use also varies between industrialised countries with the same level of income per capita as can be seen from the chart below. This suggests that considerable scope exists in reducing energy consumption for given levels of industrialisation.



International comparisons of energy consumption per capita and GNP per capita

Source: The World Bank, World Development Report, 1980.

These questions will continue to dominate energy policy discussions during the 1980s and are far from resolved. The British House of Commons Select Committee on Energy reported in 1981 that: "we were dismayed to find that, seven years after the first major oil price increases, the Department of Energy has no clear idea of whether investing around £1,300 million in a single nuclear plant (or a smaller but still important amount in a fossil fuel system) is as cost-effective as spending a similar sum to promote energy conservation."

Choices between high or low energy consumption strategies have important implications for employment. For example, in the UK considerable scope for savings of energy use exists in the housing sector. Investment in insulation, draught proofing and heating controls would have substantial rates of return when viewed in terms of the long-term benefits of energy conservation and the short-term opportunity costs of carrying it out. Compared to building new power stations, energy conservation measures have short lead times, are less capital intensive and have a shorter period of state financial commitment. They also employ relatively unskilled labour and provide jobs in urban areas, where unemployment is highest. Proposals have been made for full-scale national insulation programmes which would create jobs.

For developing countries the choice of energy consumption strategy is even more crucial, in that labour is generally plentiful and energy generally scarce. Future energy requirements and the future energy sources are closely related to the choice of technology throughout the economy rather than simply in the energy sector. The question of the choice of appropriate technology is returned to later.

New materials

Technological change in products and processes also affects the demand, output and hence employment in industries processing and extracting the materials used in those products and processes. For certain developing countries which depend greatly upon particular commodities for their export earnings, substantial shifts in demand and prices can have profound domestic effects.

One of the clearest examples of a material whose demand may be substantially affected by technological change is copper. The major part of the world's output of copper is used by the electrical, electronics and telecommunications industries. Within these industries copper has been used as the main electrical conductor, in the form both of insulated copper wire and of bare copper strip incorporated in electrical circuits and equipment. Copper strip is also used for manufacturing stampings and printed circuits. These uses have already been influenced by technological change. The development of micro-electronics and use of integrated circuits has vastly reduced the quantity of external wiring used for a given quantity of electronic circuits. More importantly the development of satellite communications and fibre-optic cables has the long-term potential of reducing substantially the use of copper in telecommunications. To some extent these effects have been offset by the expansion in output of the electronic and telecommunications sectors. But it is clear that widespread reductions in the use of copper could have drastic effects on those countries, all developing countries, which are heavily dependent upon copper exports for their foreign exchange, government revenue, and employment.

Is there a permanent shift to labour-saving technological change?

The preceding sections have given some support to the view that in the recessionary environment of the late 1970s and early 1980s technological innovation based upon microelectronics had some labour-saving bias, which contributed to problems of capital shortage and structural unemployment, particularly in Western Europe. In terms of policy implications it is important to know whether this has permanently changed production functions in certain countries or whether the labour-saving bias of technological change would be reversed in a period of sustained and rapid economic growth.

In terms of achieving policy goals of raising employment a general capital-saving bias in technological change can be seen as a blessing whereas a labour-saving bias increases the potential problems of structural unemployment. As pointed out earlier, according to the product life cycle theory the labour-and capital-saving biases of a particular innovation are likely to vary over the product's life. If technological innovations are bunched over time rather than being evenly distributed, then this would be likely to have macroeconomic effects. Waves of technologically-induced job creation could be expected to be followed by waves of job displacement and decline.

In the 1920s Kondratiev[1] attempted to show that such long-term economic cycles or long waves existed, and later Schumpeter[2] argued that variations in the rate of technological change could explain these long-term economic cycles. He argued that the development of certain key technologies as opposed to improvements in technology could stimulate a period of employment growth. As examples of such technologies he gave steam power, railways, electric power and the automobile. However, at a certain point in the cycle the labour-displacing effects of the technology could be expected to outweigh the employment expansion, and the economy could move back into recession. A number of recent commentators, notably Freeman[3], have gone on to claim that the

(1) N. Kondratiev: "The Major Economic Cycles", 1925.

(2) J. Schumpeter:"Business Cycles: a Theoretical Capitalist Process", 1939.

(3) See,for example,C. Freeman:"Long Waves in the World Economy", 1982.

growth of the electronics industry and information technology represents just such a feature of the long wave, and can be compared to the earlier innovations mentioned above. The exponents of this view argue that the expansion of employment in the electronics industries and in data processing in the industrialised countries during the 1950's and 1960's has now been replaced in those countries by a downturn in the cycle with displacement effects in other industries replacing growth in electronics. As seen in earlier sections, employment in the electrical industries as a whole has been constant in the United States and has fallen over the last ten years in Europe.

The statistical basis of the existence of long waves in capitalist, industrialised economies is far from unequivocally accepted. However, even if the long-term business cycle has occurred historically,this does not necessarily imply impotence in coping with its current manifestations. Technological innovation is not solely exogenous to socio-economic developments and therefore is itself partly determined by the economic cycles, which it may be a factor in stimulating. The fact that, in historical terms, significant periods of technological innovation have coincided with periods of rapid growth in demand and output, does not therefore on its own indicate causality. In explaining past cycles of economic activity, however, the 'bunching' of technological innovation may provide a better explanation of some periods of upturn and downturn than a straightforward explanation of multiplier accelerator interaction. However, again in the long-term, the influence of government policy in both developing and industrialised economies cannot be ignored and in the future this may well have a more significant influence upon the nature and timing of economic development than either exogenous technological developments or the internal mechanics of the trade cycle.

Nor can the activities of the major actors in the process of technological change be ignored. For example, it has been shown that the level of working time has fallen steadily in industrialised countries over the last hundred years.

This has been a way of exploiting the advantages offered by technological change. Between 1950 and 1970 30 per cent of productivity growth in OECD countries was taken in the form of reduced working time. This was in the main the result of pressure by trade unions of working people who succeeded in reaching agreements with employers or in getting legislation passed limiting working time. Pressure has mounted, particularly in Western Europe, to accelerate the process of reducing working time. If the labour-saving bias of technological change is maintained, then this may increasingly have to become part of government policies in industrialised countries.

Conclusion on the efficiency of adjustment processes

The foregoing sections therefore argue against taking a deterministic view of the impact of technological change on the level of employment. However, they also argue against complacency. Given the real world of inadequate market adjustment mechanisms and an uncertain macroeconomic environment there is a very real danger that in industrialised countries the potential advantages offered by technological change will lead to increased structural unemployment in the short and medium term rather than to increased human welfare. This is not inevitable however, and can be countered by appropriate policies by the major actors involved in technological change. As will be argued in a following section, the problems facing developing countries are of a much greater order of magnitude.

The possibility of long-term regional disequilibria

The existence of compensation effects although inadequate does give some grounds for general long-term optimism about the impact of technology upon employment. However, economic theory gives no assurance that the employment creation effects of technological change will in the long term compensate the same region or country or group of people whose jobs are displaced as a result of that change.

This is particularly so since the world economy has become increasingly interdependent through the expansion of world trade since the Second World War. Its dominant feature has become the widening gap in living standards between the developing countries and the industrialised countries. In the long term improving living standards and achieving economic development depend upon the twin processes of capital accumulation and technological innovation, which are closely related. As seen in industrialised countries, technological innovation is the result of the introduction of new technologies based upon the outcome of research and development. Developing countries have much less potential for influencing technological change themselves, since 97 per cent of the world's R&D takes place in industrialised countries. They therefore have to rely primarily upon adapting old technologies already in use in industrialised countries or new technologies currently being developed in those countries.

This situation presents three sets of issues for developing countries. Firstly they are dependent upon a process of technology transfer from industrialised countries. The most important medium in this process are multinational corporations with home bases in industrialised countries. Clearly, to obtain technology through such transfers gives developing countries an opportunity to acquire technology which was not open, for example, to European countries going through the industrial revolution in the nineteenth century. However it also means that the developing country does not always have the possibility of moulding the technology to its needs. This raises a second set of issues: that the technology which is imported may not be appropriate to the resource endowments and development needs of the developing country. Thirdly, the country's potential for assimilating technological change will tend to be much less than in industrialised countries. Rapid technological change may therefore lead to a widening of the technology gap between industrialised and developing countries rather than a narrowing of it.

It would be wrong, however, to exaggerate the homogeneity of either industrialised or developing countries with regard to their technological capability or the future impact of technological change upon them. There are more successful and less successful industrialised countries in terms of their technological performance. There are much greater differences between developing countries in terms of their degree of industrialisation, their basic infrastructure, their resource endowment, the export orientation of their industry, their population and the general diffusion possibilities for new technology. For example, 80 per cent of all capital goods production in developing countries takes place in only eight countries.

Various studies have been carried out which, by making generalisations about groups of countries, have allowed some insight to be gained as to the potential impact of technological changes in the future upon employment and income in those groups. For example, Cole[1] has examined the impact of microelectronics upon four different groups of countries:- the technology dynamic industrial economies; the less dynamic industrial economies (which include Australia, Canada and the UK); the newly industrialised economies, NICs (including Hong Kong and Singapore); and the least-developed economies (which include most Commonwealth countries). The study compares a trend scenario in which developments experienced during the period 1965-1975 continue with the scenario of what the author calls a 'microprocessor revolution'. In this scenario aggregate productivity has the potential to increase by a factor of two in the service and industry sectors. However, the implementation differs according to the group of countries, with relatively rapid implementation

(1) Sam Cole: "A Microprocessor Revolution and the World Distribution of Income: A General Equilibrium Approach", International Political Science Review, Vol.3, No 4, 1982.

in the dynamic industrial economies and little adaptation in the least developed countries.

The results of the simulations highlight the large scale of changes and the fact that "the links between economies via world markets ensure that even in economies not undergoing more rapid technological change absolute income and distribution of income are substantially changed"[1].

The countries that gain most from this 'technological revolution' are the NICs,with higher employment and income growth than under the trend scenario. However, they also become increasingly technologically dependent, and the report by Cole notes that "the imperative for these economies to adopt the technologies must compromise their negotiating position with respect to the main carriers of technology, the international firms".

In the least developed countries, however, income and employment of the higher skilled groups in the labour force is substantially lower than in the trend scenario. The lower skilled groups do somewhat better, but only because the slower growth of the industrial sector and a less competitive world food market means that there is less movement from agriculture into the industrial sector. In the industrialised world the more dynamic countries do substantially better in the new scenario than do the less dynamic. In the latter group the income and employment of the less skilled groups in the labour force is lower with the 'microelectronics revolution' than under the trend scenario.

The above results obviously depend on the assumptions of the model. For example, they ignore the adjustment processes in change. They are important, however, in indicating the distribution of gains and losses on a world scale arising from

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(1) Ibid.

faster technological change of the type described. They show that under the assumptions made in an open world trading environment the gains from a 'microelectronics revolution' are unevenly spread. They do not however give credence to the views which have been expressed that the widespread adoption of microelectronics will undermine the export-oriented strategies of the NICs by changing their comparative cost advantage. Nor do they support the view that microelectronics will offer most developing countries the opportunity to "leapfrog" the industrialisation process and rapidly close the gap in income with the industrialised countries. These conclusions are however a result of assumptions in the model, and more substantive issues are discussed below.

The impact of technological change on comparative advantage

The argument has been put forward[1] that the increased automation made possible by microelectronics will reduce the importance of direct labour costs in total costs in certain labour-intensive industries which are highly important in developing countries which have pursued export-orientated growth strategies. It is suggested that this will reduce the importance of developing countries' comparative advantage in terms of labour cost and lead to a return of formerly labour-intensive production back to the industrialised countries, which have greater advantages in terms of management techniques, coordination and marketing. The industries commonly cited as being most affected are textiles, clothing, footwear and parts of the electronics industry. In the words of King, "... automation in the North is bound to erode the comparative advantages enjoyed at present by the low labour cost countries of the South"[2].

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(1) See for example J.Rada: "The impact of microelectronics", 1980.

(2) A.King: "Microelectronics and World Interdependence", in Friedrichs and Schaff (eds.): "Microelectronics and Society For Better or For Worse", 1982.

It is certainly true that in the clothing and textiles sectors considerable research effort is being focused in the field of automating labour-intensive processes. For example, in the United States textile manufacturers are spending $2 billion per year on automation. In the EEC countries the European Commission has sponsored a basic research programme for automation in clothing manufacture, which combines together the main clothing manufacturers as well as machinery producers and manufacturers.

In the electronics sector the major international companies have rapidly increased their employment in the NICs, whereas employment in industrialised countries has grown little or has fallen. This has not just been the case in consumer electronics but also in electronic components. The share of labour costs in total production costs for integrated circuits varies in the different stages of production. In chip fabrication, labour costs form 18 per cent of the total costs, in the chip assembly they form a third of total costs and in testing 75 per cent of total costs. It has been assembly and testing activities which in the main have been the target for relocation to low wage developing countries and for automation. Given the relatively low start-up costs of off-shore assembly and testing plants and the variation in wage rates shown in the table on the next page, it is clear that overseas investment by semiconductor multinationals can be extremely volatile.

1980/81 average industrial hourly wage rates in selected countries with semiconductor assembly plants

United States	$8.09	Mexico	$1.54
Belgium	$7.91	Hong Kong	$1.26
Federal Republic of Germany	$7.16	South Korea	$1.10
Netherlands	$6.96	Singapore	$1.00
France	$6.14	Taiwan	$0.90
UK	$5.92	Philippines	$0.62
Ireland	$5.16	Indonesia	$0.45
Italy	$4.63		

Source: "Electronics", quoted in Global Electronics Newsletter, No 21, April 1982 and Eurostat for European figures.

It would be wrong, however, to overemphasize the likely effects of changes in comparative advantage on employment in the developing world. Labour costs have not been the sole determinant of the pattern of world trade, employment or investment. Other factors such as raw materials, energy, markets, geographical location, government polices are just as important. Indeed, one recent ILO study has even gone so far as suggesting that labour costs are relatively unimportant in determining multinationals' investment decisions. The study concludes that: "... local wage levels do not play any significant part in the technological choice made by MNE (multinational enterprise) subsidiaries and that government legislation on minimum wages, contrary to what was often assumed, does not appreciably accelerate the shift to more capital-intensive technology in the enterprises"(1).

In some NICs, such as Singapore, government policy has deliberately attempted to raise the level of real wages and the level of skills

(1) "Technology choice and unemployment generation by multinational enterprises", ILO, 1984.

of the labour force to move to the higher technology areas of production. A greater problem indicated in the simultations referred to above is one of increasing technological dependence of the NICs. The nature of investment carried out by multinational companies may limit the extent to which a transfer of technology can be integrated into the structure of the economy. In electronics,for example,one commentator has noted that: "semiconductor assembly is based on a technology bearing virtually no relation to that required in the various front-end semiconductor processes like circuit design, mask generation and wafer fabrication. Hence, the transfer by semiconductor firms of their assembly operations to developing countries has not enabled those countries to develop fully integrated semiconductor industries"(1).

Some commentators do not share this assessment and have argued that the experience of some NICs, such as Singapore and South Korea, has shown that strategies can lead towards the development of integrated production activities in certain product categories. Indeed the question has been asked as to whether the development of integration per se is a necessary goal for developing countries to pursue. It is undoubtedly true that the NICs have managed to raise their income and development levels through export oriented strategies. These strategies, in their first stage at least, were not aimed at the development of integration industries but at benefiting from specialisation and comparative advantage. An issue of importance is the extent to which NICs, having achieved initial development through specialisation and export orientation, can successfully move into the development of indigenous industries and less labour-intensive activities.

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(1) D.O'Connor: "Global Trends in Electronics: Implications for Developing Countries", World Bank, 1983.

A second issue of importance is the extent to which the export-oriented industrialisation strategies which have been followed by the NICs can be usefully adopted by other developing countries. Without denying that important lessons can be learned from the NICs' experience, it is also true that the majority of NICs have been small countries which have benefited from natural advantages, and a judicious balance of government policy and exploitation of international market developments. The OECD, in reviewing the experience of NICs, has warned that "outward-looking policies may, in some instances, result in unbalanced growth, over-emphasising directly productive as opposed to infrastructural investment, and industrial and urban over agricultural and rural development. They may also favour an uneven distribution of incomes, limiting domestic absorption. As development proceeds, there will be a need to raise the share of urban and social infrastructures in total investment and reduce inequalities of income distribution between sectors and income categories."(1)

"Bypassing industrialisation"

Some commentators have argued rather optimistically that technological advances, and in particular microelectronics, give developing countries the possibility to bypass the industrialisation process and 'leapfrog' into a position of higher growth and development. To quote one critique of such views: "the argument is a strange anagram of rhetoric that borrows from notions of self-reliance, basic needs, appropriate technology and modernisation, combined with an imaginative, though

(1) OECD:"The Impact of the Newly Industrialising Countries", 1979.

unrealistic, interpretation of the development process[1].

As seen, economic development depends as much upon the process of capital accumulation as upon technological innovation. If the evidence reported earlier is correct, that microelectronics-based innovation is currently incorporating a labour-saving bias, then this could have the opposite effects of those mentioned above and aggravate the already large problems of capital shortage and underemployment in developing countries.

Perhaps, more importantly, the evidence suggests that even if capital shortage is not a problem, the large majority of developing countries will have severe difficulties in applying current technological change due to shortage of labour skills and a basic technological infrastructure. One commentator has noted that: "the important point with respect to electronics is that the advantage of an abundance of technically trained labour power and a strong indigenous scientific and research infrastructure may more than offset the disadvantage of a relative shortage of capital for a particular developing country"[2]. It is, however, these very factors that the majority of developing countries lack.

It is also doubtful to what extent some technology developed in industrialised countries is directly relevant to developing country needs. The 'Green Revolution', for example, by helping to increase rural inequality and create an unskilled agricultural labouring class, appears to have exacerbated agricultural problems in some developing countries, rather than solving them. The same may be true of the application of microelectronics. The danger exists of both the electronics producing and using industries acting as a useless and costly

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(1) Atul Wad: "Microelectronics: Implications and Strategies for the Third World", Third World Quarterly, No 4, 1982.

(2) D.O'Connor: "Global Trends in Electronics: Implications for Developing Countries", World Bank, 1983.

accessory to the main development requirements of developing countries. The report by O'Connor argues: "the electronics industry of a developing country can only contribute substantially to the broader process of industrialisation when it is fully integrated into that process. By grafting an electronics industry onto the immature sapling of an underdeveloped economy one does not thereby ensure the growth of a sturdy trunk from which will branch out a diverse yet closely intertwined array of thriving industries"(1). Here the importance of integration into the rest of the economy is emphasised rather than the integration of the electronics industry itself.

Undoubtedly, certain innovations may prove of great value in meeting developing countries' needs. For example, remote sensing by satellite provides new sources of information with regard to raw material deposits and land use. The key issue, however, is whether such information is made available to developing countries or whether it remains in the hands of private corporations and is simply used to strengthen their negotiating position with the developing countries. Even if information is made available freely to developing countries, the question remains of whether they possess the infrastructure to use it in practice.

National technology policies

In the longer term it is clear that countries can influence the impact of technology upon them and can widen the spectrum of technological choices available to them. To this end, national technology policies can play an important role as part of overall development policies. In conclusion, it is worth restating UNCTAD's suggestions for the ingredients of national technology policies. These should include:

- Unpackaging of technology (i.e. splitting imported technology into smaller units, some of which may be able to be supplied locally);

(1) D.O'Connor: 1983, op.cit.

- Adapting and developing imported technology for domestic use; hiring design and engineering consultants to help with the choice and use of imported technology;

- Ensuring the supply of accurate information to governments and technology users on choices available and how to utilise them;

- Ensuring standardisation and quality control; promoting appropriate education and training (particularly scientific and technical education);

- Fostering demand for domestic technology, particularly pursuing policies which produce a more even distribution of income which in turn stimulates demand for basic foods, clothing, housing, etc. rather than high cost luxury imports;

- Finding an effective role for public sector enterprise;

- Exerting influence over the private sector (through measures such as financial policy, taxation and investment incentives, trade policy and import sustitution efforts);

- Providing finance for technology development (e.g. through levies on industrial turnover or special taxes);

- Coordinating different technology policies and the institutions for implementing them.

II. IMPACT ON THE QUALITY OF WORK

The quality of work

Defining or measuring the qualitative aspects of work is a highly subjective process. Nevertheless, in practice people do make judgments about satisfying and dissatisfying aspects of work and considerable experience has been built up in analysing what determines job quality. This suggests that the main determinants of job quality are: job content; its meaningfulness; the learning involved; working environment; job security; social contact; rewards; and the impact upon leisure time. Important factors affecting job content include the skill requirements, the responsibility, the freedom from supervision, the control over work pace. In determining a job's meaningfulness it is important for a worker to see the role the job plays in the overall production process and see its relevance to the final product.

A superficial review of the nature of work in both industrialised and developing countries suggests that outside of small elites few people have genuinely high quality jobs. Even in the industrialised countries, where life expectancy, education and income are all far higher than on average in the developing countries, the majority of working people have unsatisfactory working environments. A survey carried out in the Federal Republic of Germany[1] in 1981 found that:

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(1) H.Hennings: Arbeitsplätze mit belastenden Arbeitsanforderungen, in Mitteilungen aus der Arbeitsmarkt und Berufsforschung, 4, 1981. (Percentages are of total employed population).

- 6.4 million employees (29 per cent of the total) were exposed to high levels of noise;

- 6.2 million (28 per cent) worked according to tightly defined procedures and schedules;

- 5.2 million (24 per cent) worked in an excessively wet, cold, hot or draughty environment;

- 4.2 million (19 per cent) worked in a physically uncomfortable position;

- 4 million (18 per cent) were exposed to hazardous environmental factors such as smoke, dust, gases;

- 3.8 million (17 per cent) were required to use considerable physical effort;

- 3.1 million (14 per cent) were engaged in night and shift work.

Another German study[1], undertaken in 1977, estimated that 33 per cent of men and 46 per cent of women employed carried out repetitive jobs with low responsibility, whilst 11 per cent of men and 40 per cent of women carried out jobs involving simple auxiliary tasks. Despite these factors, the FRG is often described as one of the industrialised countries with rather better working conditions.

It is against this background that a debate has developed in the industrialised countries over the impact of new technology, and especially microelectronics, on the quality of work.

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(1) European Foundation for the Improvement of Working and Living Conditions: "New Forms of Work Organization in Western Europe", 1979.

Quality of work in developing countries

Questions of the quality of work are not just relevant to industrialised countries however. Developing countries have their own particular problems which, due to lower general levels of income per capita and under employment, are far harder to deal with. In many developing countries the drive for capital accumulation, industrialisation, agricultural reform and growth has meant that questions of quality of working life have received relatively low priority. In addition, the main source of technological change in developing countries has been the transfer of existing technologies from the industrialised countries. The Director General's report to the ILO Conference in 1975 noted that: "dissatisfaction with conditions of work is itself aggravated by the fact that the technologies and forms of organisation, often imported, were devised in a different socio-technological setting, and are not always adapted to social and cultural environments in which they are actually applied".

It has been pointed out that the 'Green Revolution' in the agricultural sectors of some countries has not always had the positive economic effects that were hoped for it. Some of the qualitative aspects of agricultural work have also deteriorated as a result of changes. For example, surveys of areas using modern varieties of rice in some developing countries[1] have shown that it has led to a reduction in the volume of family labour and an increase in the volume of hired labour. This, along with other factors, such as economies of scale arising from the use of high yielding varieties, has led to the creation of landless agricultural labour force in an economy without a basis of stable employment to support them.

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(1) See various papers in ILO:"Technology to Improve Working Conditions in Asia", 1979.

In the industrial sectors problems have also arisen with the importation of technology through 'turnkey' projects which when faced with very different cultures, infrastructure and environment do not operate technically in the same way as in industrialised countries. This may frequently lead to increased social problems at workplace level in the form of increased accidents and stress.

There are also examples frequently cited of 'dirty' industries or production processes which are no longer accepted in the industrialised countries because of their social cost, being transferred to developing countries. There is evidence, for example, of asbestos production and use,which is progressively being restricted in industrialised countries for health reasons,being transferred to developing countries.

Some developing country governments have emphasised that questions of quality and living and working environment cannot be allowed to interfere with development of objectives. In terms of the question of priorities this is clearly an understandable desire. However, in many areas the two objectives of quality and quantity need not conflict in the long term. Through developing a more educated labour force and higher quality jobs some developing countries have shown that technological change and improved working conditions can be compatible. The Director General of the ILO stated in 1975 that:

"in the more developed countries it is now being realised that an organic link exists between the volume and quality of employment. The creation of more and better jobs could be not only a social proposition but also an economic aim. I feel convinced that the social will has a dynamic force capable of affecting classical economic analyses. We saw this in the Sixties when we launched the World Employment Plan. Contrary to certain theories which were prevalent at the time, we suggested that employment development should become a major aim in development policies. The same boldness, born out of a similarly powerful social conviction, leads us today to put forward these two working hypotheses

which I shall now sum up and which are in line with the best traditions of this Organisation. First, it is essential not only from the immediate social point of view, but also from the point of view of subsequent economic progress, which is the foundation of social progress, to invest in the improvement of working conditions, irrespective of the degree of development of the country concerned. Secondly, this improvement, far from hampering the aim of employment development, strengthens it"[1]. Domestic conditions and policies may be more important than a particular technology in influencing working conditions.

The relationship between technology and job quality

Many of the factors affecting the impact of technology on job quality are analogous to the factors affecting the level of employment. Technological change has conflicting effects on the quality of work in the same way that it has conflicting effects on the level of employment. The introduction of technological product and process innovations may well lead to the deskilling of some jobs and the upgrading of others compared to existing products and processes. In some cases, new technology has led to an improved physical working environment, whilst in other cases it has led to problems of increased isolation of the worker, increased supervision of work and the changed pace of work.

These conflicting effects reflect the fact that a particular technology does not determine a particular form of work organisation or a set of working conditions. The impact upon the working environment will be the result of a set of choices made

(1) ILO: International Labour Conference, 60th Session, 1975. Record of Proceedings, p.193.

during the planning and introduction of the new technology. Where these choices are made consciously it is the economic, technical or social objectives which the technology is used to achieve that determine its effects upon employment in general and working conditions in particular. If a rational assessment is made of the longer term economic and social choices presented by new technology, then certain positive opportunities for improving living standards and the quality of working life do exist. If, however, the driving force behind technological change is one of rationalisation, increasing measured productivity and short-term profit, then this may well lead to a general deterioration in the quality of work.

In talking of job quality and technology it is useful to draw a distinction between tasks and jobs. Any job is likely to be made up of a series of different tasks. Whilst the tasks may be directly related to a particular technology the jobs are socially determined. Whether all the boring and repetitive tasks are concentrated in one set of jobs and the interesting tasks in another set of jobs, or whether they are distributed across different jobs, is an organisational rather than a technological decision.

If the driving force behind technological change is rationalisation, then new technology based on microelectronics offers considerable scope for deskilling and standardising jobs which at present require a high level of skill and training. This reduces the dependence that employers have upon groups of skilled workers, for example skilled craftsmen in the printing industry. New technology can also be used to achieve greater management control over the type of work and pace of work of

a formerly skilled craftsman. In turn, new technological elites are created upon whom employers depend and who can command, in the short term at least, high salaries in return for their skills. In the present case the new technology has produced a demand for computer specialists: systems analysts, programmers, and electronics engineers. A future wave of rationalisation and technical innovation may deskill and standardise these jobs. In fifteen years time the unemployed and redundant computer programmer may have replaced the unemployed steelworker or displaced typesetter in industrialised countries as the object of retraining programmes or early retirement.

The dangers of this pattern of development are considerable, not only for skilled workers in existing industries but also for society as a whole. New technology may result in societies becoming even more polarised than they are at present. On the one hand there may be a mass of lowly-skilled operators monitoring highly automated systems of production and competing for their jobs with the unemployed, and on the other hand a small technological elite.

These problems of deskilling are not just related to current technologies. A similar process was seen in the nineteenth century during periods of industrialisation. De Tocqueville wrote in 1835: "when a workman is increasingly and exclusively engaged in the fabrication of one thing, he ultimately does his work with singular dexterity: but at the same time he loses the general faculty of applying his mind to the direction of the work. He every day becomes more adroit and less industrious; so that it may be said of him that in proportion as the workman improves the man is degraded".(1) The same effect is true of some of the technological change taking place today.

(1) De Tocqueville: "Liberalism", 1835.

Alternatives do exist, however, to design computer systems which use the existing skills of the workforce and add to them computer-related skills associated with the new technology. This may mean less central management control than technological options which concentrate computer skills requirements in a few centralised technical jobs; but it is likely to result in a better end-product and better quality jobs. The cost savings may not be so dramatic but the end result will be better.

Some examples

In industrialised countries one of the activities where technological change has resulted in a general deskilling of craftsmen has been in use of computer numerically controlled (CNC) machine tools. A study by Senker[1] of the use of CNC machines in the British tool-making industry found that the skill required by craftsmen tended to be reduced. In most industrialised countries the operators of conventional machine tools have traditionally been highly rated within the hierarchy of manual jobs. The task is highly skilled and requires a long period of training. The tasks of the machinist include assisting with the planning of the production of a part, setting up the machine, and controlling the speed and operation of the machine according to varying local circumstances such as the quality of the metal. Whilst the job involves communicating with both management and the draughtsman and designer of a part, the machinist retains a high degree of freedom and control over his job.

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(1) P. Senker et al: Technological Change, Structural Change and Manpower in the UK Toolmaking Industry, E.I.T.B., 1976.

The introduction of computer numerically controlled (CNC) machine tools can be seen as a process innovation which is generally substitutive in its effects on labour skills. The skills of the machinist are broken down into their logical components by the analyst and programmer and the computer is programmed to control the operation of the machine tool in a similar way to the machinist. The control of the machine tool is transferred from the operator to the systems specialist, who analyses his skills. The job of the machinist is changed into one of monitoring the computer controlled equipment.

Similar experiences have been found with other forms of computerised equipment. A case study of a British firm where electronic process control machinery was introduced found that: "probably the most striking change in work organisation is the substantial transfer of skill from the shop floor to the office. In particular, although shop floor operatives have always been classified as semi-skilled, the more experienced workers and the foreman previously played a major role in setting and adjusting machinery. Now it is more or less established that setting is carried out by process controllers"(1)

The result of these and other case studies, however, suggests that the impact of CNC upon working conditions and skill levels is not fixed or inevitable. To quote one study: "there is no effect of CNC use as such,...it is inadequate to consider a production technology as given and observe effects on constraints which follow from it,...technical development interacts with organisation and manpower development"(2). The key variants

(1) B. Wilkinson:"On the Negotiation of the Technical and Social Organisation of Work: A Case Study of the Application Process Control Mechanisms", 1981.

(2) A. Sorge et al: "Microelectronics and Manpower in Manufacturing", 1983.

affecting the impact of the technology on the job content include:- plant and company size; batch size; type of cutting and machinery; national institutional structure; and socio-economic conditions.

Where CNC is introduced to provide increased flexibility and design sophistication in the product rather than increased productivity, a highly centralised form of work organisation may not be satisfactory. Different organisational options do exist with the introduction of CNC machines. Due to the reduction in cost of computing brought about by microelectronics, data processing facilities are now distributed to the level of the machine tool. This means that operating programmes can be edited and altered at the level of the individual machine by a system of manual data input. Under centralised systems of CNC machine tools, any editing of programmes would be carried out by a computer programmer from a data processing department. In practice, however, it is possible for the machine tool operators to carry out an editing function if trained in basic computer programming skills. Indeed, in cases of small batch production or relatively straightforward production requirements it may be possible for CNC machines to be programmed at the shop-floor level. For example, a comparison of the introduction of CNC equipment in Germany and Britain found that the work organisation differed quite substantially between the two countries, even with the same technology. The German structure of organisation and skills favoured more the maintenance of control over work planning at shop-floor level[1].

Such options may lead to increased skill requirements in the machinist's job by harnessing existing mechanical skills with new computer skills. They may also lead to a better end-product. In the words of one writer, "it is usually easier to train a production engineer into the skills of part programming than it is to instil into a computer programme a lifetime's experience of feeds and speeds"[2].

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(1) A. Sorge, op.cit.

(2) D. Hearn: Shop Floor and Management Aspects of Machine Tools", 1978.

Similar choices exist in the introduction of new technology in office work. For example, in industrialised countries word processing systems are coming to be used more and more widely in secretarial work. The introduction of word processing systems affects the skill levels of secretarial work in two ways. Firstly, it can result in a change of work organization with a splitting of typing work and administrative work. Secondly, it changes the skills required by the copy typist.

The introduction of word processors is frequently done through the establishment of a separate word processing department which would receive the bulk of typing work within an organization. This allows machinery to be kept working more intensively than is the case with traditional secretarial work structures and so achieves the maximum use of the capital equipment. The changed work organization results in the 'deskilling' of the word processor operator compared to a traditional secretary, since the job becomes one of essentially typing and no longer contains more varied administrative roles. Contact between typists and authors is also reduced as normally material is fed through the supervisor of the word processing department, who would also deal with any queries.

This organisational structure as described is only one of a number for introducing a word processing system into an organization. An American survey[1] of the introduction of word processing systems has described four different structures. One is a centrally administered system within an organization where all correspondence secretaries are located at the word processing centre and all typing within the organization is sent there. An alternative is to have satellite centres with typists trained in specialist typing skills and housing both administrative and correspondence secretaries.

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(1) John Brennan: Quoted in J.Burns: "The Automated Office", Datamation, April 1977.

A third structure would have a back-up centre as an overload system for traditional secretaries. A fourth structure is to have a decentralised system where word processing facilities are located in the normal departments and less division takes place between the work of administrative and correspondence secretaries. The less centralised the system the less polarisation of skills that takes place.

It is clear therefore that in the introduction of office technology, choices concerning work organization do exist. The choice of whether or not to set up a highly centralised word processing department responsible solely for correspondence typing, with independent departments containing their own administrative secretaries, is a social decision, not a technical one. An equally feasible organization is for word processors to be used on a shared basis so that the correspondence content of several secretaries' jobs could be reduced, allowing more time for administrative tasks.

Although taken from industrialised countries, the above examples can also apply equally to developing countries. Choices exist concerning the impact of technological change on working conditions. Education and training policies are however essential to ensure that technological change does not lead to the substitution of unskilled jobs for formerly skilled artisanal jobs. Two commentators have argued:- "... high-tech industry, especially the manufacturing processes located in offshore locations like Singapore, will always be intensive in the use of unskilled, especially unskilled female labour. In many products and processes, rapid technological change, short product life-cycles, small series and customised production make automation difficult and uneconomic. Unskilled labour is the most flexible factor of production, since it can be retrained and redeployed more easily and quickly than a new machine can be designed and manufactured. It can also be profitably employed in small-scale and fluctuating production. Where there is automation and computerisation, equipment must still be run by human hands, and frequently has a 'deskilling' effect i.e. manual, visual and decision-making skills become less important for production operators, whose learning curves have not lengthened with technological upgrading."(1)

(1) Quoted in Global Electronics Information Newsletter, No.47, October 1984.

Conclusions

The main conclusion of this section is that the impact of technology upon the quality of work largely depends upon the objectives for which it is introduced. If the main goal is rationalisation and increased central control over working practices, then there is a danger of increased polarisation and segmentation occurring in most workplaces. If wider social goals are also treated as priorities, then substantial opportunities exist for improving the quality of work through technological innovation. These two sets of social and technical objectives need not be in conflict with one another. The earlier they are both introduced into the process of technological change the greater the scope for achieving them both. Where inevitable conflicts do exist however, it is better that these are faced up to at an early stage and reconciled rather than being ignored, as they are likely to emerge at a later stage when technology is in use. The need for mechanisms in handling the points of conflict is returned to in the later section on agreements for negotiating technological change (see pages 270-299).

III. NEW TECHNOLOGY AND HEALTH AND SAFETY AT THE WORKPLACE

General considerations

Closely related to the impact of technology on the working environment is its impact on health and safety. The influence of the working environment upon the health of working people is the result of a wide range of factors acting in combination. These include technical factors such as the materials used, manufactured and produced in the workplace and the equipment and production methods used. It also includes the social and organisational environment, and many of the qualitative work aspects referred to in the previous section will have an impact upon the health of the workforce.

It is useful to distinguish between three types of health and safety issues. Firstly, there are cases of dangerous and unhealthy working environments leading to industrial accidents and easily identifiable industrial illnesses. The ILO has estimated that in industry alone 50 million serious accidents take place a year. In industrialised countries on average one worker in ten suffers an industrial accident resulting in a loss of work. In the EEC countries each year between 9,000 and 10,000 deaths occur due to accidents at work and nearly 6 million accidents take place in total. The incidence of accidents is probably much higher in developing countries, although difficult to calculate.

Secondly, there are less easily identifiable cases of industrial illnesses arising due to exposure to health hazards at work. These may take many years to appear in the individual and it may take much longer to prove the link between the illness and the work. For example, it took many years for

conventional wisdom in industrialised countries to accept the links between dust and chest disease in mineworkers, or the links between working with carcinogenic substances such as asbestos and subsequent fatal diseases. In an ideal world developing countries should have the advantage of being able to learn from the experiences of workers in industrialised countries with regard to long-term hazards. In reality, however, experience suggests that many hazardous jobs are exported to developing countries because health protection standards are lower.

Thirdly, there are clear links between general improvements in the working environment and general standards of health. In particular in the last decade industrialised countries have come to consider much more closely the links between psychological aspects of work such as stress and boredom and physical illnesses.

Technology affects all these aspects of health and safety at work, but a particular technology does not have inevitable consequences upon health. For example, increased computerisation offers important opportunities for reducing health and safety problems by:- allowing the automation of jobs in dangerous or unhealthy environments, e.g. paint spraying; providing better monitoring of industrial processes and so reducing the risks of accidents; removing the need for repetitive and boring jobs through automation; providing better information on health and safety issues,available more easily through computerised data bases. However, computerisation also poses dangers to health such as:- increased robotisation leading to increased accident risk; increased use of visual display units leading to eyesight problems; deteriorating work quality leading to increased stress; increased shift work leading to health problems.

The likely impact of given technology on health will therefore reflect the goals it is designed to achieve and the way it is introduced. A British government report has stated: "In theory robotics could also have applications where the repetitive nature of a job offers the risk of boredom leading to the careless use of existing machinery. In practice health and safety criteria are not always the most significant factors in determining whether processes are automated though they may clearly lead to such investment decisions if manpower simply cannot be recruited".(1)

Some examples

The two leading edge technologies, microelectronics and biotechnology, have brought with them very different, but very important sets of health and safety questions. As seen, microelectronics has led to the expansion of computerisation throughout the working environment in industrialised countries. Visual display units (VDUs) have become the standard means of communication between people and computers and as a result their use has spread widely throughout working life: currently in the United States there are more than 10 million VDUs providing access to computer systems. It is estimated that by 1990 more than half the workforce in industrialised countries will use VDUs.

As VDU use expanded in industrialised countries in the 1970s, it was accompanied by a growing number of health problems experienced by users such as eye-strain, stress fatigue, headaches and skin inflammation. It has also been recognised that

(1) UK Department of Employment: "The Manpower Implications of Microelectronics Technology", 1979.

VDUs can cause problems by increasing isolation at work. The exact effects depend on a complex range of factors covering both the equipment and work area. With regard to the equipment relevant factors are: screen brightness; colour of display; character definition; size and spacing; 'flicker' rates; tube implosion/explosion; radiation; heat generation; noise; cabinet design; maintenance and keyboard design. With regard to the work areas, relevant factors are: lights and glare; paperwork; position of screen; keyboard and paperwork; space and overcrowding; posture. Other important ergonomic factors are the opportunity for regular breaks away from the equipment so as to allow human contact and rest. Without this, the operator of a VDU can spend a whole working life looking at and interacting with a machine rather than with other people. This can lead to very real social and psychological problems for white-collar workers in the same way that mechanisation has led to problems for other groups of workers.

Some of these problems have been overcome by better design of equipment and workplaces. In several countries collective agreements or national regulations have been introduced which specify the way in which VDUs are used so as to minimize health risks. In general, the requirements of a safe use of VDUs are that: neither natural nor artificial light should cause glare on the screen; the characters on the screen should be easily readable; noise from the equipment should be kept to a minimum; the design of keyboards, desks and chairs should conform to ergonomic standards so as to avoid fatigue; VDUs should be positioned so as to allow social contact, but avoid overcrowding; operators should be given regular eye tests; operators should be given regular breaks away from VDUs. Research in some countries has also been directed at producing more ergonomically satisfactory VDUs through changing flicker speeds or developing new forms of displays.

Many of these problems have been overcome in the design of modern equipment. However, in the words of one VDU expert, "standards are still necessary because there are plenty of old VDUs about and we still manage to make the same old mistakes, especially at the bottom end of the market"(1). For developing countries the real danger is that the 'same old mistakes' will become the norm.

Conclusion

As with the impact of new technology on the quality of work, it is clear that its impact on health and safety at the work-place is both varied and capable of being influenced in advance. Part of the problem is to ensure that adequate research is carried out in time to examine the health implications of certain technologies. It is then important that effective standards are adopted and implemented. The earlier the health and safety implications are dealt with the more likely it is that good standards can be compatible with economic and technical goals.

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(1) Tom Stewart - member of International Standards Organisation ergonomics technical committee addressing International Trade Union Conference on VDUs, Geneva, October 1984.

PART II

AGREEMENTS FOR NEGOTIATING TECHNOLOGICAL CHANGE

I. TECHNOLOGICAL CHOICES

Previous sections of this report have shown thatthe introduction of new technology can result in very substantial changes in both the level and pattern of employment on a global, national, regional and industrial basis. These in themselves reflect changes taking place at the level of the enterprise or organisation and indeed at the level of the individual workplace.

Manning levels, skill requirements, the working environment, health and safety, career prospects, job satisfaction, working time and pay levels are all features of working life which may be quite dramatically transformed by technological changes. Changes may in fact be at their most dramatic when new 'greenfield' enterprises are established incorporating state of the art technology and quite different work organisation structures from existing plants in the same sector, industry or area.

A central theme of earlier sections has been that the overall direction and impact of these changes is not predetermined by the technology. As seen in different social and economic environments, a particular technology may have very different effects. The impact upon the working environment will also be affected by the choices made by the 'actors' involved in introducing new technology. The 'actors' include those who are responsible for introducing change, normally management, and those who will have to work with the technology, the workforce and their trade unions. Conscious technological choices may be made to achieve certain organisational objectives

at the expense of others. For example a particular technological option may be chosen on the basis of its cost saving or rationalising potential irrespective of the effect that this may have upon employment levels or the health of workers involved. However, frequently technological choices may be made unconsciously where alternative technological options are simply not known or considered when change is planned and implemented. For example in many enterprises, even in advanced industrial countries, when a new computer system is designed the systems analyst will never be asked to consider the impact of his design upon the jobs of the people who will have to work with that system. The possibility of meeting both social and economic objectives is therefore never raised.

For the 'actors' involved in implementing and coping with changes the scope of choice may seem constrained by a range of features such as the economic position of the firm, time constraints, lack of expertise and organisational pressures. The task of policy-making must be to widen the scope of choices by lifting constraints and to make the 'actors' aware of alternative choices. It must then ensure that procedures are introduced which allow optimum choices to be made. This covers the range of economic and social policies which accompany change but it also covers the institutional arrangements by which change is introduced at a workplace level. This section considers the implications of technological change for industrial relations systems and some conclusions about best practice and model agreements.

II. CONFLICT OF INTEREST OR SHARED INTEREST?

A pluralistic view of change

The arguments described in earlier sections concerning the economic and social costs and benefits of technological change

reflect to some extent different sociological, just as much as economic, views of the world. On the one extreme our societies are depicted as having a unity of interest where technological change is often depicted as being wholly desirable and bringing benefits to all. On the other extreme societies are interpreted solely in terms of class conflict in which technology is essentially a weapon of one group in society against another.

Depending upon where one is placed in society it is convenient to interpret events through an ideology in which everyone should agree with one's view of the world. Those who gain from technological changes in the short term are likely to adopt a unitary analysis in which their interests are perceived as being in everyone else's interests as well. This could be paraphrased as what's good for General Motors is not only good for the United States but for mankind as well. On the other hand those whose direct interests are threatened by change are likely to adopt a class conflict analysis in which potential benefits that may accrue to everyone arising from technological change are discounted.

In reality most Commonwealth countries are essentially pluralist societies in which, as has been seen in the short term, the adjustment process is likely to mean that technological change will result in costs and benefits being distributed unevenly between groups. This will mean that there may often be a conflict of interest between different groups. Over time generalised benefits will flow from harnessing technological innovation which surpass many of these short term conflicts. However, it has also been pointed out that the danger can exist of certain groups or regions remaining permanently disadvantaged.

The optimum position must be to ensure that there is a trade off between different costs and benefits so that short term conflict does not prevent long term benefits being achieved. Arriving at this optimum requires the existence of systems for representing the interests of different groups affected and the possibility of negotiation based upon equality of power. At the enterprise level it is just this trade off possibility that industrial relations systems are designed to offer.

Within some high technology producing and using industries the importance of ensuring high quality products and the importance of the workforce in this process have led to what have been called 'new personnel management' policies being introduced. Such policies have different emphases in different countries but often include such questions as communication of management goals to the workforce, the establishment of 'quality circles' etc. Such measures may well be desirable in their own right but they are not necessarily an alternative to effective industrial relations procedures. Effective industrial relations procedures need to allow workforce representation to be autonomous from management if it is genuinely to represent their interests. This representation has to be a 'bottom upwards' process of personnel management rather than a 'top downwards' one. Moreover much of the agenda and orientation of the 'quality circle' approach is to involve the workforce in the achievement of management goals rather than to reconcile these with the independent objectives and interests of the workforce.

Different interests within an organisation

The most obvious groups with defined sets of interests likely to be affected by technological change are management on the one hand and the workforce and their trade unions on the other. For many countries, particularly in developing countries, these interests will be closely influenced in practice by the involvement of public authorities and governments in both industrial and labour policy.

At the level of the organisation, other and more complex sub-divisions of interest may also take place. Organisational research suggests that the firm itself, within industrialised countries at least, is a highly pluralist organisation. "The firm may be represented as a series of large horizontally divided groups, divided by the nature of task, routinisation, generality of skill or knowledge, responsibilities and spheres of authority. It is divided vertically by the degree to which its market and status reference groups lie within or outside the firm. This segmentalised labour market constitutes a series of areas within which any given technological innovation has a different impact and presents differing opportunities or grievances. The shape of the resulting production function may, in the short run at least, result from the nature of the structure and the process of the negotiations within each of these areas as upon the existence of an overriding technological imperative"(1). If this view

(1) J. Child and R. Loveridge (University of Aston): "Capital Formation and Job Generation within the Firm in the UK - a review of the literature and suggested lines of research" - Paper delivered to First EEC Symposium in Social Sciences, September 1981.

is correct then arguments over management prerogative have little practical relevance and trade union concern over workforce interests is clearly a legitimate issue to be raised in the change process.

One potentially useful generalisation is that management is primarily responsible 'upwards' within a firm through management hierarchy whereas trade unions are responsible 'downwards' to their membership. These two main actors can therefore be attributed different sets of generalised objectives which they may seek to maximise in the process of change.

Objectives of management

The organisational objectives which management will be seeking to achieve will typically include:- profit maximisation or optimisation, reduced costs, increased productivity, a reduced labour force, reduced waste, net budget targets, new product development. These will vary to some extent between product and process applications.

A survey of microelectronics use in British industry[1] for example found that advantages perceived by management arising from microelectronics use in products included:- better product performance (considered very important by 70 per cent of respondents), flexibility in new product development (66 per cent), more consistent quality product (54 per cent), lower production costs (47 per cent), greater customer appeal (42 per cent), higher sales volumes (31 per cent), and higher profit margins (23 per cent). Advantages perceived by management from using

(1) Policy Studies Institute : "Microelectronics in British Industry: The Pattern of Change", London, March 1984.

microelectronics in processes included better control of the production process (rated very important by 75 per cent), a more consistent, better quality product (74 per cent), more efficient use of labour (66 per cent), capital equipment (48 per cent), materials (45 per cent) and energy (35 per cent), and also lower costs of production (54 per cent), greater speed of output (49 per cent) and better working conditions (20 per cent). It would seem reasonable that these perceived advantages would correspond broadly to desired organisational objectives of management.

Objectives of trade unions

Trade unions would be expected to regard a separate set of objectives as priorities. For example, the British Trades Union Congress's checklist for negotiators covering new technology agreements[1] sets out besides a series of procedural objectives a list of substantive objectives concerning new technology. These recommend that union negotiators should:- press for increased production from new technology rather than job cuts; seek guarantees on job security; if necessary negotiate voluntary redundancy/enhanced redundancy pay; agree retraining schemes; seek reduced working hours; reward new skills; distribute the benefits of new technology across the workforce; ensure no machine monitoring of workers; monitor Visual Display Unit health hazards. The overall objective is therefore to use new technology to improve working conditions in the field of skills, hours, income, health and safety, training, job satisfaction and job security.

Most of these issues are closely affected by other factors apart from technological change. For example, as seen in the section on "The Impact of Technological Change on Employment", the question of job security and new technology is closely bound up with market and macroeconomic developments. For trade unions, new technology does have the importance of raising a whole set of issues related to working life at the same time in a way that few other changes do. When new technology is being discussed, so are most aspects of the working environment.

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(1) Trades Union Congress: Employment and Technology, London, September 1979.

The reconciliation of objectives

Although trade union and management objectives towards new technology are clearly different from each other, they need not always be in direct conflict. Whether they are or not depends upon the possibilities offered by various technological choices. As seen from earlier sections in this report technological and organisational options exist whereby improvements in qualitative aspects of work need not necessarily conflict with meeting management goals such as lower costs or higher productivity. For example most computer manufacturers sell terminals with Visual Display Units which have separate keyboards from screens, and adjustable brilliance controls and printers with noise covers. These fairly basic features of good ergonomic design were not available on VDUs sold ten years ago. Pressures from VDU operators in Western Europe, largely channelled through their trade unions, forced computer manufacturers to respond through changes in product design involving little extra cost. For users there are both economic and social gains.

In some cases, however, high costs may be imposed either in lower productivity on the one hand, or in greater health hazards on the other, by particular technological options. For example, societies in Western Europe have now deemed that the health hazards imposed upon workers through working with asbestos outweigh the economic benefits accruing to the companies manufacturing and using asbestos. This had led to the public regulation of asbestos use and manufacture. This was not brought about however by a sudden impulse of social responsibility by legislators, but by constant pressure by trade unions over the last two decades since the health hazards of working with asbestos have become evident.

Conflicts are bound to arise therefore where the introduction of new technology does not allow the twin goals of improving the working environment and maximising cost reduction to be achieved at the same time. The conflict may be similar to one that arises between firms and consumers over product quality. If one aspect of the firm's output is regarded as the quality of the jobs it offers to its workers and the workers in this case are the consumers of that output, then the analogy may be fairly close. The goal in the long term should be to aim for improved quality of product and not just cost reductions, in the field of working conditions just as much as in the field of the end product. In the words of one writer: "Informed customer participation in product development is quite commonplace nowadays in high technology industries, and some transfer of those constructive supplier-customer attitudes to the realm of management-worker negotiations over changes in working conditions does not seem too much to ask for."(1)

One problem with new technology is that it may obscure the basic choices which are available to workers in terms of cost/benefit options and obscure the areas where real conflicts of interest may arise. This problem is analogous to the problem of product novelty in the consumer field, where a consumer may not be aware of the problems and advantages of a new technically complex product before buying it.

It is desirable that in handling technological change, mechanisms are developed whereby the conflicts involved in technological change are made explicit rather than remaining implicit and which allow compromises between different interests to be reached.

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(1) P.A. David: "Microelectronics and the Macroeconomic Outlook", Stanford University Discussion Papers, 1982.

It is in the long term interest of both management and the workforce to have procedures which enable conflicts to be resolved on the basis of equality of power. One writer has summed up the issue in saying that: "The introduction of new technology may, on the one hand, present management with the opportunity to break down worker organisation, yet the very resistance that this induces may limit management's ability to introduce best practice techniques"(1).

The successful introduction of new technology ultimately depends upon the people operating the systems. If individuals feel aggrieved or resentful in a changed work environment they are unlikely to be working efficiently and may well frustrate and hinder the attainment of management objectives. The effort expended in solving potential problems and reconciling conflicts of interest before technological change is implemented is a worthwhile investment for management. Long term gains will outweigh the short term expediency of acting unilaterally.

When faced with a grievance at the workplace an individual may have two options for setting right the problem. These options have been described by some writers as the 'exit' and the 'voice' options. The 'exit' option would lead an individual to quit the firm and try to find an alternative job. This is clearly not a viable option in many circumstances. The 'voice' option would lead the individual to voice the grievance to management. By acting as a collective voice, trade unions can protect the individual from victimisation and institutionalise the 'voice' option of grievance handling. It is not surprising therefore

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(1) J. Rubery: "Structural labour markets, worker organisation and low pay", Cambridge Journal of Economics, 1978, No.2.

that turnover rates in unionised firms tend to be much lower than in a non-unionised environment faced with an otherwise similar labour market environment. A study by Freeman and Medoff[1] on the impact of unionisation in the United States found that turnover rates were 30 to 65 per cent lower in unionised compared to non-union plants. Largely as a result of this they found that productivity was higher in unionised plants than non-union plants. In a union environment it was also found that the joint regulation of rules made management more professional and less arbitrary in its personnel policy, which also led to economic gains. Overall they concluded that the welfare gains to the American economy as a whole arising from the collective 'voice' actions of trade unions outweighed the welfare losses arising from any monopoly behaviour in the labour market leading to higher wages at the expense of employment.

There exists therefore considerable scope for developing institutional structures for handling technological change through negotiation between management and trade unions which are to the advantage of both parties. It is significant that this is reflected in the attitudes of both management and trade unions in those areas where such procedures have already been implemented.

In the UK the National Economic Development Council carried out in 1983 a survey of firms in the electronics sector to examine the degree to which they provided information and consulted their workforces on the introduction of new technology[2].

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(1) R. Freeman and J. Medoff: "What do Unions do?", New York, 1984.
(2) NEDC: "The Introduction of New Technology", London, 1983.

They found that of the firms who involved their employees in the process, all recorded improved industrial relations as a result of consultation. The specific benefits attributed to consultative arrangements by management included :-

- "increased commitment through involvement"
- "greater understanding of commercial and technical decisions by those on the shopfloor"
- "better understanding by managers of the issues that arise in the process of rapid change"
- "reductions in the amount of time involved in introducing new techniques"
- "increased readiness to accept redeployment"
- "improvements to the design of the product".

None of the managers attributed any damage to the firms' competitive performance as a result of their consultative procedures.

The specific benefits attributed to consultative arrangements by trade unions included :-

- "extension of negotiating rights to influence the process of introducing change, especially advance consultation with the company before it makes final decisions on system introduction and the possibility of monitoring its extension"
- "the introduction of change on an agreed planned basis"
- "increase in pay for new skills"
- "to stop or slow job loss, and especially to prevent redundancies"
- "to protect and improve working conditions, especially health and safety, and skill levels"

- "improved productivity".

Where dissatisfaction was expressed on the part of union respresentatives it mainly concerned the perception of management commitment to the agreement.

Similarly, a survey of case studies of the introduction of new technology in Western Europe carried out for the European Commission[1] found that in 'best practice' examples of the use and provision of information to trade unions, considerable advantages were perceived by management from the process. For example in a case study of a Swedish dairy where trade unions had been involved from the design stage in the investment in a 'greenfield site', the manager, although originally sceptical, subsequently admitted to researchers that the interventions by the worker representatives had important and valuable consequences for the design of the new dairy, the new work organisation and the transition to the new site. The technical staff were even more enthusiastic about the advantages which arose from the early and extensive involvement of worker representatives.

III. PRACTICAL EXPERIENCES

Strategies adopted

The preceding sections have sought to show that a 'best practice' approach to the introduction of new technology at workplace level brings with it substantial economic and social advantages. In reality strategies adopted over recent years have differed substantially from such an approach.

(1) Hugo Levie et al. : "Workers and New Technology; Disclosure and Use of Company Information",DG V EC, 1984.

Managements, rather than seeking to introduce change on the basis of consensus, have in many circumstances sought to manage by concealment or by the use of fear to get employee acceptance of change. There are still many examples of work-forces finding out about technological change for the first time when machinery is delivered to workplaces. Change is often offered on a take it or leave it basis whereby the fear of unemployment is used to coerce workers to accept change and where cost cutting and rationalisation are the sole objectives of change. In industrialised countries this management approach to change has undoubtedly been reinforced by the growth in unemployment and the current fear of redundancy. In many developing countries a unilateral approach to change may well be the norm. As is argued later in this section there may be particular problems in firms in the Export Processing Zones of certain countries where different labour standards apply from the national norm.

On the trade union side responses may vary quite widely as well. Broadly, four different approaches have been adopted: outright opposition to change; enthusiastic acceptance of change; conditional acceptance 'after the fact'; and attempts to influence change 'before the fact'.

The response of outright opposition to change has been one adopted by some organisations of working people where they have perceived that their interests are likely to be permanently damaged as a result of changes. In societies which offer little in terms of compensation to groups affected, such a reaction may be understandable in terms of self interest. Groups of workers may be expected to pay the full cost of changes for which society as a whole benefits. As pointed out in the section on the "Impact of Technological Change on Employment", Ricardo, writing on the effect of industrialisation in the early 19th century on industrial workers in Britain, commented that their opposition to change was "conformable to the correct principles of political economy"

In some developing countries the debate is still raging over the desirability or otherwise of introducing computer technology as a process innovation in services such as banking. In India, for example, a furious dispute has taken place between different banking unions, notably the National Organisation of Bank Workers and the All Indian Bank Employees Association, over the latters' agreeing to the computerisation proposals put forward by the Indian Bankers Association.

However, the strategy of outright opposition to technological change is unlikely to succeed in protecting jobs in the medium or long term. In the United States the typographers' union in the newspaper industry, the ITU, resisted the introduction of computerised type-setting in the late 1960s and early 1970s. This was due to the loss of employment opportunity and status that computerisation threatened for its highly skilled members. Ultimately, however, the union found that the bargaining position of its members was undermined by new technology, as disastrous strikes at the Washington Post and New York Times showed.

Even if total resistance to change was a feasible strategy, it would normally mean that incomes in general would remain lower than would otherwise be the case and so not be regarded as desirable. Few unions in industrialised countries are advocating outright opposition to technological change, and surveys suggest that union resistance, although varying widely between countries, is not a major fact on restricting change in practice. One comparative study of the introduction of microelectronics in industry in Britain, Germany and France found that "opposition from the shopfloor or trade unions has been a major difficulty for 16 per cent of the user establishments in the samples in France and 14 per cent in Germany, but for only 7 per cent in Britain. In Germany it is a problem experienced mainly in the longest establishments and in the mechanical engineering industry; in Britain most often in the printing industry".(1)

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(1) Policy Studies Institute: "Microelectronics in Industry", 1985.

The other extreme union approach to change can be called 'enthusiastic acceptance'. Some unions have undoubtedly enthusiastically accepted the introduction of new technology as a way of increasing the competitiveness of their industry and hopefully preventing jobs going abroad or attracting new jobs. In those developing countries where growth has been focused on the export sector, trade unions have often actively supported the rapid introduction of product and process innovation, coupled with the expansion of training to raise skill levels. In Singapore, for example, the trade union movement has acted as a pressure on management to innovate as quickly as possible and raise skill levels in line with government policy. In the Republic of Ireland, which has also faced the problem of how best to achieve industrialisation from a predominantly rural base, the Irish Transport and General Workers Union has actively encouraged the introduction of new technology in firms.

Clearly such a strategy from a national trade union reflects the development strategy for the country as a whole. As was clear from earlier sections in this report however, whilst such an approach may be possible for an individual country or industry, it cannot be applicable to all. Indeed against the current background of virtually no overall growth in jobs, gains in one country tend to be at the expense of those elsewhere.

The third union approach to change, and probably the one which is the norm in most industrialised countries, could be called conditional acceptance of new technology 'after the fact' of its introduction. For example the Canadian National Union of Provincial Government Employees is quoted in a government report as saying "Our union is not naive enough to think that it can stop the revolution, nor do we want to. To the contrary, we want to be part of it"(1). Unions have sought to extract from management the best safeguards and best terms and conditions for their members that are feasible. The exact terms of agreements on technology have varied according to the

(1) Labour Canada: "In the Chips: opportunities, people, partnerships", 1982.

relative strengths of management and unions and the tools available to them through legislation or other means. Typical issues covered have been: the avoidance of redundancies and the handling of job displacement through natural wastage and retraining; income guarantees for displaced workers; the changes in pay systems and demarcation rules to cope with change; reduced working hours; and health and safety questions.

In the Federal Republic of Germany, for example, agreements at national level have been concluded across all major sectors affected by the introduction of new technology. In general, these have been defensive in nature. They have sought to protect workers from the negative effects of rationalisation and technological change, in particular against redundancy and downgrading. At work council level, trade unions have sought to use legal rights to information, consultation and regulation to influence new technology before it is introduced. Other rights which are relevant to the introduction of new technology are given in the health and safety legislation.

In the UK attempts to extend joint regulation of new technology have focused on the extension of collective bargaining through the conclusion of new technology agreements (NTAs). More than one hundred agreements have been surveyed, the majority of them concluded at company level.

However, for manual workers at least, the NTA represents the exception rather than the normal means by which the introduction of new technology is regulated. For white collar workers the NTA has been an important means for seeking regulation, in part because many of these groups are currently being affected directly by new technology for the first time.

It should be pointed out that whilst the bulk of NTAs concluded in Britain have been of an essentially defensive nature, they have been concluded over a short period and in a time of decreasing employment and falling production.

Similarly, in Australia the Australian Council of Trade Unions have recognised that in practice much technology is handled after the fact' by trade unions. In their 1983 Congress statement on technological change policy, the ACTU said "The failure of Governments and employers over a period of years, to give other than lip service to the need for planning the introduction of beneficial new technology, or for the social consequences that flow, particularly in the current economic circumstances, can only be interpreted as a rejection of the trade union movement's appeal for, and willingness to participate in, the planned introduction of new technology".

Whilst such approaches are necessary and in many cases valuable, unions have recognised that they still amount to defensive and reactive responses to changes proposed by management. This has led unions in some cases to try and develop the fourth strategy referred to earlier, namely to attempt to influence technological change 'before the fact' of its introduction.

For example, achieving effective technical control against the background of computer technology is not just a question of laying down procedures or regulations for handling machinery or the computer hardware. It requires an influence over the design of the systems of which individual jobs and individual pieces of equipment form a part. For trade unions this process

of influencing systems design means getting access to management at a much earlier stage, as soon as, or indeed before, change is contemplated. It means harnessing the knowledge and demands of work groups concerning the production process and harnessing outside expertise to demystify the technology. It requires a greater emphasis on union education and research programmes as well as obtaining rights to information from management. But at the end of the day it also means maintaining the unions' bargaining power and right to veto changes. Such 'before the fact' strategies are inevitably more difficult and deal with issues that are less tangible than straightforward responses to change. But they offer the best real hope of influencing change.

Procedures in industrialised countries

The 'best practice' approach is therefore one in which management and union jointly agree and decide upon technological change at the planning stage and before the change is introduced. The actual procedures for ensuring that this occurs are likely to vary according to the industrial relations practices of a country.

The Table below summarises the way in which technological change is regulated at the workplace in some industrialised countries. As can be seen, in some countries legislation has laid down basic trade union rights in coping with change, such as the work environment and codetermination laws in Sweden. Elsewhere custom and practice or general framework agreements have laid down rights, such as in Norway and Denmark. In some sectors, including printing, sectoral agreements are the norm, whilst in others company level or local agreements covering technology have become increasingly widespread (e.g. FRG and UK).

SUMMARY OF PROCEDURES OF JOINT REGULATION OF TECHNOLOGICAL CHANGE IN SELECTED INDUSTRIALISED COUNTRIES

COUNTRY	UNIONISATION RATE %	LAWS USED	COLLECTIVE AGREEMENTS		
			NATIONAL FRAMEWORK AGREEMENTS	SECTORAL LEVEL	COMPANY OR PLANT LEVEL
FRG	40	1)WORKS CONSTITUTION ACT 1972 2)WORKS SAFETY ACT 1973 +REGULATION ON WORK WITH VDUs 1981	NONE	JOB PROTECTION AGREEMENTS IN METALWORKING, TEXTILES, FOOTWEAR, LEATHER, PAPER PROCESSING, PRINTING	UPWARDS OF ONE HUNDRED AGREEMENTS CONCLUDED
GREAT BRITAIN	50	HEALTH AND SAFETY AT WORK ACT 1975	NONE	PARTS OF PUBLIC SECTOR	UPWARDS OF ONE HUNDRED AGREEMENTS
NORWAY	45	WORKING ENVIRONMENT ACT 1977 + REGULATION ON WORK WITH VDUs 1982	1975 AGREEMENT ON COMPUTER BASED SYSTEMS NAF-LO	BANKING	MOST OF INDUSTRY AND SERVICES COVERED BY LOCAL AGREEMENTS
DENMARK	70		1981 AGREEMENT FOR PRIVATE SECTOR BETWEEN LO AND DA	BANKING/PUBLIC SECTOR	
SWEDEN	75	1)WORKING ENVIRONMENT ACT 1978 + REGULATION ON WORK WITH VDUs 1981 2)CODETERMINATION ACT 1977	WORK ENVIRONMENT AGREEMENT SAF-LO-PTK 1976	TECHNOLOGY AGREEMENT IN THE PRINTING SECTOR, CODETERMINATION AGREEMENTS IN CENTRAL GOVERNMENT, LOCAL GOVERNMENT, PRIVATE SECTOR	USE OF LEGISLATIVE RIGHTS
ITALY	45	1)STATUTE OF WORKERS RIGHTS 1970 2)HEALTH AND SAFETY ACT 1978	NONE	CLAUSES INCLUDED IN SECTORAL AGREEMENTS ON METALWORKING	CLAUSES INCLUDED IN SEVERAL COMPANY AGREEMENTS EG FIAT, OLIVETTI, ALFA ROMEO
BELGIUM	75		1983 COLLECTIVE AGREEMENT ON NEW TECHNOLOGY	PRINTING	LOCAL AGREEMENTS IMPLEMENTING NATIONAL AGREEMENT
UNITED STATES	20		NONE	TECHNICAL CHANGE CLAUSES IN GENERAL AGREEMENTS	
AUSTRALIA	45	UNFAIR DISMISSAL LEGISLATION	NONE	TELECOMMUNICATIONS	AGREEMENTS IN PARTS OF PRINTING & PUBLIC SECTOR
CANADA	30	RECOMMENDATIONS FOR LEGAL RIGHTS	NONE	LIMITED CLAUSES IN EXISTING AGREEMENTS	
JAPAN	25		"	TELECOMMUNICATIONS	PLANT COMMITTEES
OTHER COUNTRIES		HEALTH & SAFETY LEGISLATION (EG FRANCE) CO-DETERMINATION LEGISLATION (EG AUSTRIA)	NONE	PRINTING SECTOR IN THE NETHERLANDS, AUSTRIA, GREECE	

In Canada technological change has led a Government 'task-force' to recommend substantial changes in labour legislation. They have argued that: "The legislative scheme which we envisage would require all employers of 50 or more employees to engage in ongoing discussion and consultation with employees or their representatives, in anticipation of technological change."(1) The task-force went on to recommend the establishment of Joint Technology Committees between manangement and unions and to introduce arbitration in cases of disputes over the introduction of new technology.

In Australia the Government have published for discussion a national technology strategy which proposes a range of actions in the area of industrial relations including:- the establishment of principles of good management practice; the establishment of minimum standards in federal awards regarding unfair dismissal; consultation on the introduction of new technology; and the introduction of guidelines covering union consultation on the introduction of technological change. The ACTU has demanded that in addition, the Government should establish a national office of technology assessment.

It is significant that in the United States in the 1970's, unlike the 1960's, there had been relatively little concern at the impact of new technology on workplace relations in general and employment in particular. Concern was also less in Japan. In part, this can be explained by the fact that this period was one of relatively rapid employment

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(1) Labour Canada:"In the Chips" : Opportunities, people, partnerships", 1982.

growth in each country. Both Japan and the U.S. gained from some of the shifts in the pattern of world production and employment that were taking place as a result of technological change and, against a background of relatively rapid growth, the traditional areas of highly organised labour were less seriously affected by job loss due to new technology. The less articulate groups on the periphery of the labour market in both countries were in a less favourable situation.

There is however, increasing activity in the field of negotiations over new technology in both the United States and Japan. In the United States a survey of technological change clauses in collective bargaining agreements(1) has shown that such clauses had increased modestly in number during the 1970's, with a more marked increase in the non-manufacturing sector. The clauses cover a wide variety of subjects but most extensively workforce reductions, then retraining and wage security. The most common procedural issue covered was the advance notice of technological change, accompanied by provisions for consultation or negotiation.

In Japan, the trade unions have begun to raise the question of how to expand trade union influence in the introduction of new technology. In July 1982, one of the trade union national centres (SOHYO) published a report on trade unions and technological renovation which argued that they should "enlarge the sphere of union's regulatory influence, so as to be able to cover the area of production and technology management and cope successfully with technological renovation". The report went

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(1) Ken Murphy:"Technological change clauses in collective bargaining agreements", AFL-CIO,Washington, August 1981.

on to argue that "if enterprise unions try to enlarge their influence individually without organising themselves, they are certain to be retaliated by a heavy market pressure resulting from inter-enterprise competition".(1)

The relevance for developing countries

The industrial relations background in industrialised countries covers a wide range of situations. Unionisation rates vary from 70-80 per cent of the labour force in some Scandinavian countries down to 20-30 per cent in the United States, Japan and France, with countries such as Australia, Britain, Germany and Italy falling mid-way in the range. Nevertheless, the establishment of joint procedures for handling technological change has become more and more a common feature of the differing industrial relation systems.

The situation in developing countries is much more variable, reflecting very different political and economic structures. Partly due to the high proportion of agricultural employment and under-employment in the labour force, the unionisation rates tend to be low when measured at national level. However, the overall low unionisation rates obscure pockets of high and effective organisation in certain economic sectors and geographic areas. For example in a country such as India, although the national unions claim a total membership of less than 8 million compared to a total labour force of some 250 million, the estimated unionisation rate in the economic sectors subject to unionisation is around 30 per cent. The pattern of unionisation in high technology sectors varies considerably between countries but probably reflects the general national norm for other industrial sectors.

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(1) SOHYO : "Trade Unions and Technological Renovation", Report No.1 - July 1982.

Even where trade unions have less organised strength than in industrialised countries they may have political influence due to close links with political parties. For example in Singapore the National Trades Union Congress (NTUC) has very close relations with the major political party PAP. And besides organising one third of the labour force, the NTUC also runs a wide range of corporations including supermarkets, insurance, child care centres and taxis. It is significant that the NTUC in Singapore works closely with the government in pursuing the development objective of raising skill and wage levels so as to influence the pattern of industrial development.

The importance of the state in tripartite procedures, as opposed to bipartite ones, can pose difficulties for trade unions in developing countries as well as advantages. In developing countries as a whole, the ability of trade unions to organise, their ability to take industrial action and the scope of negotiable issues is more closely restricted by the state than in industrialised countries. A crucial factor affecting the ability of trade unions to regulate new technology in some countries is therefore whether governments see this as desirable. Changes in government policy and in some cases legislation may therefore be necessary in order to facilitate the way for the negotiation of technological change.

In some countries it is also the case that the ability to establish independent trade unions and their ability to operate normally is restricted, either by government action or by the activities of employers. In these circumstances it is understandable that the priority objective has been to establish free trade unions and basic trade union rights, rather than immediately to extend the negotiating remit into areas such as new technology.

The ratification and application of ILO conventions gives one benchmark by which to compare the application of what have come to be known as 'good labour standards' The Table below shows the extent to which basic conventions concerning trade union rights and labour conditions have been ratified in two groups of countries, one of industrialised countries(EEC) and the other of developing countries (ASEAN).

Ratifications of ILO Conventions December 1983 in ASEAN and EEC Countries

	1	26/131	81	87	89	98	100	111	138	141	144	151
ASEAN												
Indonesia	-	-	-	-	-	x	x	-	-	-	-	-
Malaysia	-	-	x	x	-	x	-	-	-	-	-	-
Philippines	-	-	-	-	x	x	x	x	-	x	-	-
Singapore	-	-	x	x	-	x	-	-	-	-	-	-
Thailand	-	-	-	-	-	-	-	-	-	-	-	-
EEC												
Belgium	x	x	x	x	x	x	x	x	-	-	x	-
Denmark	-	-	x	x	-	x	x	x	-	x	x	x
Germany	-	x	x	x	-	x	x	x	x	x	x	-
Greece	x	-	x	x	x	x	x	-	-	-	x	-
France	x	x	x	x	x	x	x	x	-	-	x	-
Italy	x	x	x	x	x	x	x	x	x	x	x	-
Luxembourg	x	x	x	x	x'	x	x	-	x	-	-	-
Ireland	-	x	x	x	x'	x	x	-	x	-	x	-
United Kingdom	-	x	x	x	-	x	x	-	-	x	x	x
Netherlands	-	x	x	x	x'	-	x	x	x	x	x	-

Ratified Conventions

No. 1 Hours of Work
No. 26/131 Minimum wage-fixing Machinery
No. 81 Labour Inspection
No. 87 Freedom of Association and Right to Organize
No. 89 Prohibition on Night Work for Women
No. 98 Right to Organize and Collective Bargaining
No. 100 Equal Renumeration
No. 111 Discrimination (Employment and Occupation)
No. 138 Minimum Age
No. 141 Rural Workers' Organizations
No. 144 Tripartite Consultation
No. 151 Labour Relations (Public Service)

Source: ILO quoted in Background Paper for ICFTU Conference on the trade union role in ASEAN/EEC relations

An equally important point has been the extent to which ILO conventions are applied in practice in developing countries, even when they have been ratified. The application of ILO conventions within Export Processing Zones (EPZs) has been one area of particular concern. The ICFTU, for example, has argued that workers in EPZs in practice face particular difficulties in organising and operating[1]. As a result of these concerns the ILO since 1981 has been surveying the effect of the creation of EPZs in various parts of the world on the application of ratified conventions. Its conclusions have been summarised each year in its annual Report (see for example the 1984 report[2]). It has noted that in some countries (e.g. Pakistan) labour standards in EPZs have posed problems for the implementation of conventions. In others (e.g. Mauritius) EPZs have had lower labour standards, for example on holidays, overtime and night work for women, but this has mainly concerned conventions which have not been ratified by the countries concerned. In general, however, the ILO has noted that many of the countries possessing EPZs have not submitted information to them.

It is important to note that in some countries with export oriented industrialisation strategies the attitude of public authorities to trade union activities is changing. In Malaysia, for example, there was until 1983 a government ruling that workers in electronics sectors could not join the Electrical Industry Workers' Union (EIWU) on the grounds that it represented workers in a different industry. The Malaysian Trade Union Congress and the International Metal Workers' Federation lodged a complaint with the ILO in 1979 against this ruling. It was changed in 1983 and organising activity has been carried out by workers at several plants with the help of the EIWU. In April 1983 the EIWU won recognition at an ITT subsidiary's plant based in one of the

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(1) International Confederation of Free Trade Unions (ICFTU): "New Technology and Womens' Employment", 1983.

(2) ILO Report of the Committee of Experts on the Application of Conventions and Recommendations, 70th Session, 1984.

Malaysian EPZs. This followed a government ruling after the union had recruited 423 of the plant's 530 workers. Even where trade unions are organised they may have considerably greater difficulties in handling the issues thrown up by new technology than trade unions in industrialised countries. Strategies of trade unions in developing countries may therefore often reflect the 'outright rejection' or 'enthusiastic acceptance' strategies described earlier in this section. They may find it more difficult to effectively influence change in a way that is both socially and economically desirable. One of the key issues affecting both trade unions and developing countries in general is the importance of education and training of the workforce and trade union representatives to enable them to handle issues of technological change.

Despite the extra difficulties in developing countries concerning negotiating technological change, it is argued in this report that the approach of introducing change with agreement is the most desirable strategy in the long term. The previous sections of this report have shown that by acting as a collective voice, trade unions can have a positive impact on efficiency and productivity and the ultimate technological choice made at enterprise level. This is just as valid in developing countries when new technology is introduced as in industrialised countries. It is sometimes claimed that by raising wage costs in developing countries, trade unions would reduce comparative advantage vis-à-vis the industrialised world. However, in reality trade unions are only likely to have a significant impact on wage levels when they are working with market forces rather than against them. Indeed when new technology is introduced, this can allow the goal of higher incomes to be met through higher productivity rather than higher prices. It should also be pointed out that trade union strategies for higher incomes are only likely to succeed when they coincide with government development objectives, as seen for example in Singapore.

Finally it is worth emphasising the link between political and industrial democracy. Independent trade unions represent an

important pillar of democratic, pluralist societies. Developing their capabilities and representativeness on issues such as technological change is an important factor in encouraging political democracy.

IV. A MODEL AGREEMENT

Despite differences in practical application therefore, the extension of negotiations on the introduction of new technology is regarded by this report as a desirable goal. The main features of 'best practice' approaches contained in agreements and legislation is summarised below[1]:

Procedurally, the agreements typically specify :

- the commitment of both management and trade unions to the introduction of new technology and the satisfactory management of change;
- the provision of information by management to the trade unions on the introduction of new technology, at an early stage, before decisions are taken and when final choices can be influenced. The information should allow for transparency with regard to the effects of changes and the choices to be made;
- the establishment of management/union bodies to discuss, monitor and negotiate change;
- the opportunity for the election and training of trade union representatives with specific responsibilities for monitoring the introduction of new technology, but with close links to the membership;
- the possibility of access by the union in a plant to outside expertise, in some cases paid for by, although independent from, management;
- the establishment of a procedure for monitoring and regulating the collection of personal data on individuals working in a plant and for regulating its use;
- the inclusion of a 'status quo' clause whereby the unions have the right to veto changes unless they are agreed.

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(1) For a more extensive model agreement see that published by the International Federation of Commercial Clerical Professional and Technical Employees (FIET), Geneva, 1983.

In terms of the substantive issues regulated by these procedures, agreements typically specify that:

- there should be 'no redundancies' as a result of the introduction of new technology. In some cases, unions have even been able to ensure that there should be no reduction in the volume of employment;

- staff whose jobs are changed or eliminated due to technological change should be retrained and given jobs of comparable status in the same enterprise. Downgrading should be limited;

- for older workers, voluntary schemes of early retirement should be introduced and, in general, working time should be reduced to ease employment problems;

- the introduction of new technology should not be used to increase the pace of work, control and supervision or to reduce job contact or lead to a higher incidence of shift working;

- the health and safety aspect of working with computerised equipment and visual display units (VDUs) should be closely regulated; the design of the equipment and working place should conform to ergonomic standards; the amount of time spent working with VDUs should be limited; regular breaks away from the machine should be provided for; and regular medical check-ups made available;

- the personal information collected on employees should be strictly limited to that relevant to the activities of the company;

- the pay levels of displaced workers should be guaranteed; new grading levels should be introduced for those operating new equipment, but it should not be used to increase pay differentials.

These points might be taken to represent a code of good practice in introducing new technology. It is clear that the particular institutional form of agreement or approach needs to be adapted to national circumstances. In developing countries, particular attention needs to be given to establishing and developing free trade unions in the first place and then to developing training and education to equip the workforce and its representatives with the expertise to handle the issues raised by technological change.